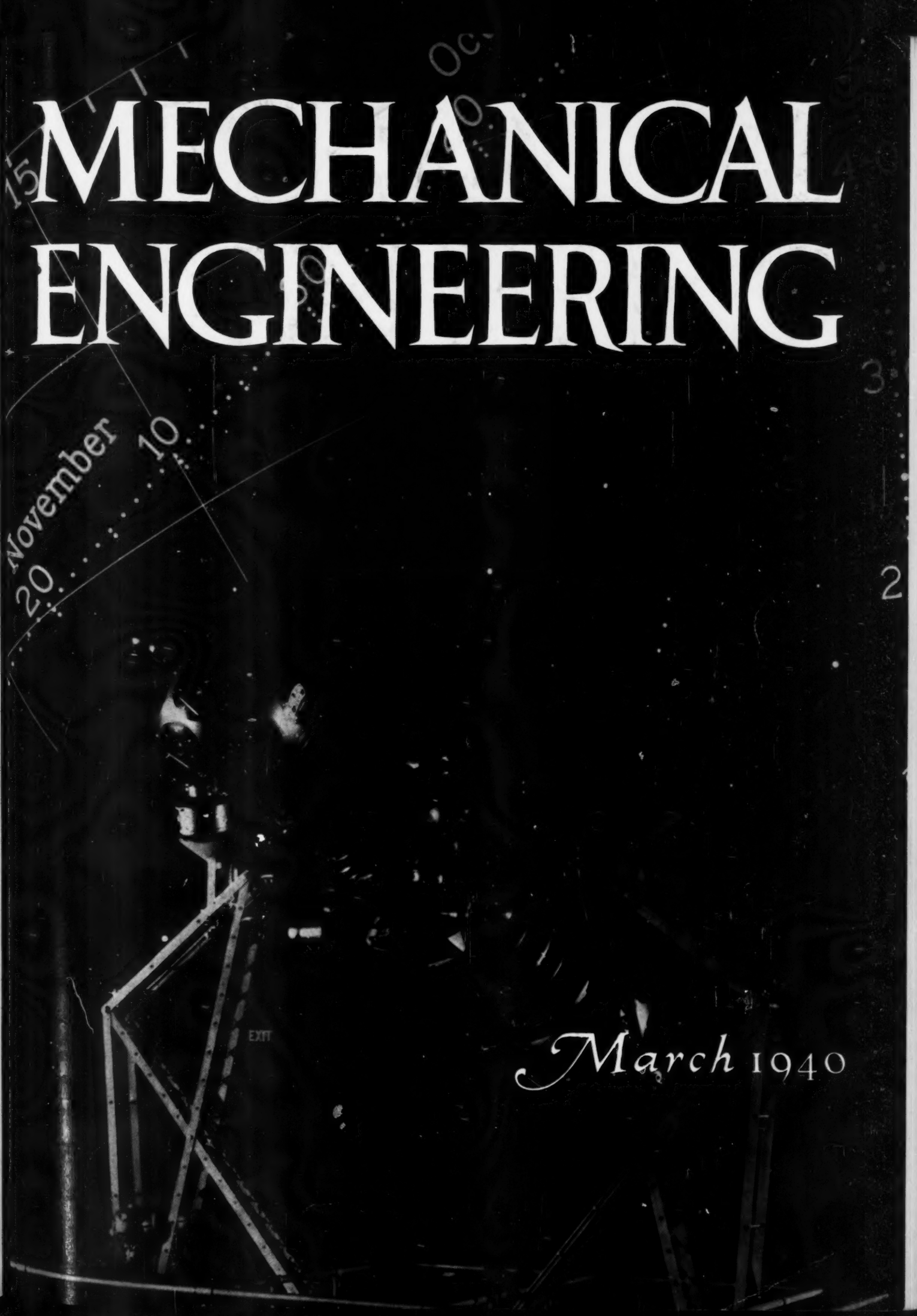
MECHANICAL ENGINEERING



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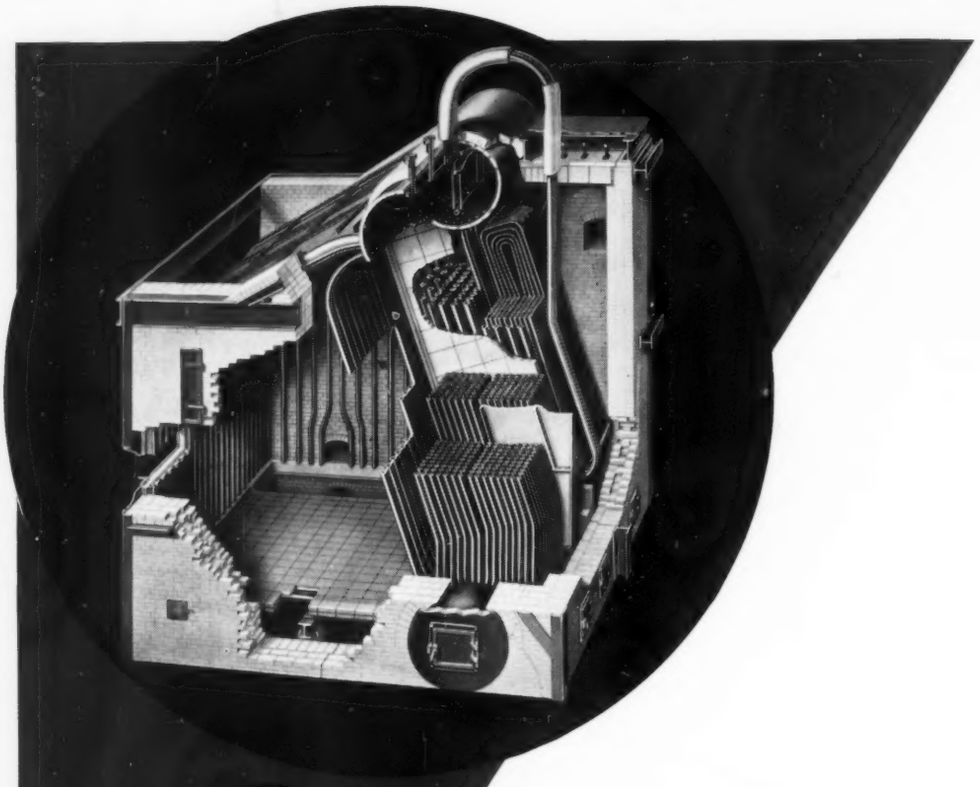

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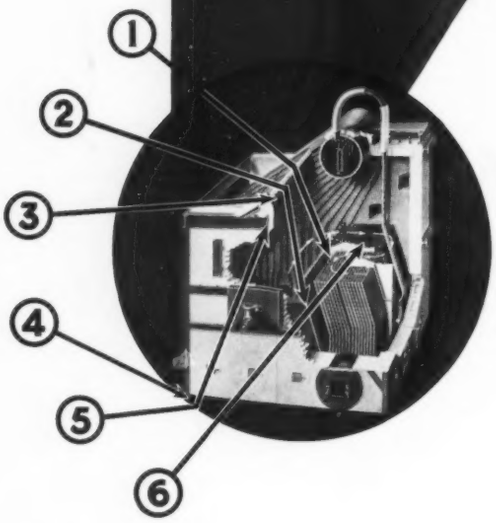

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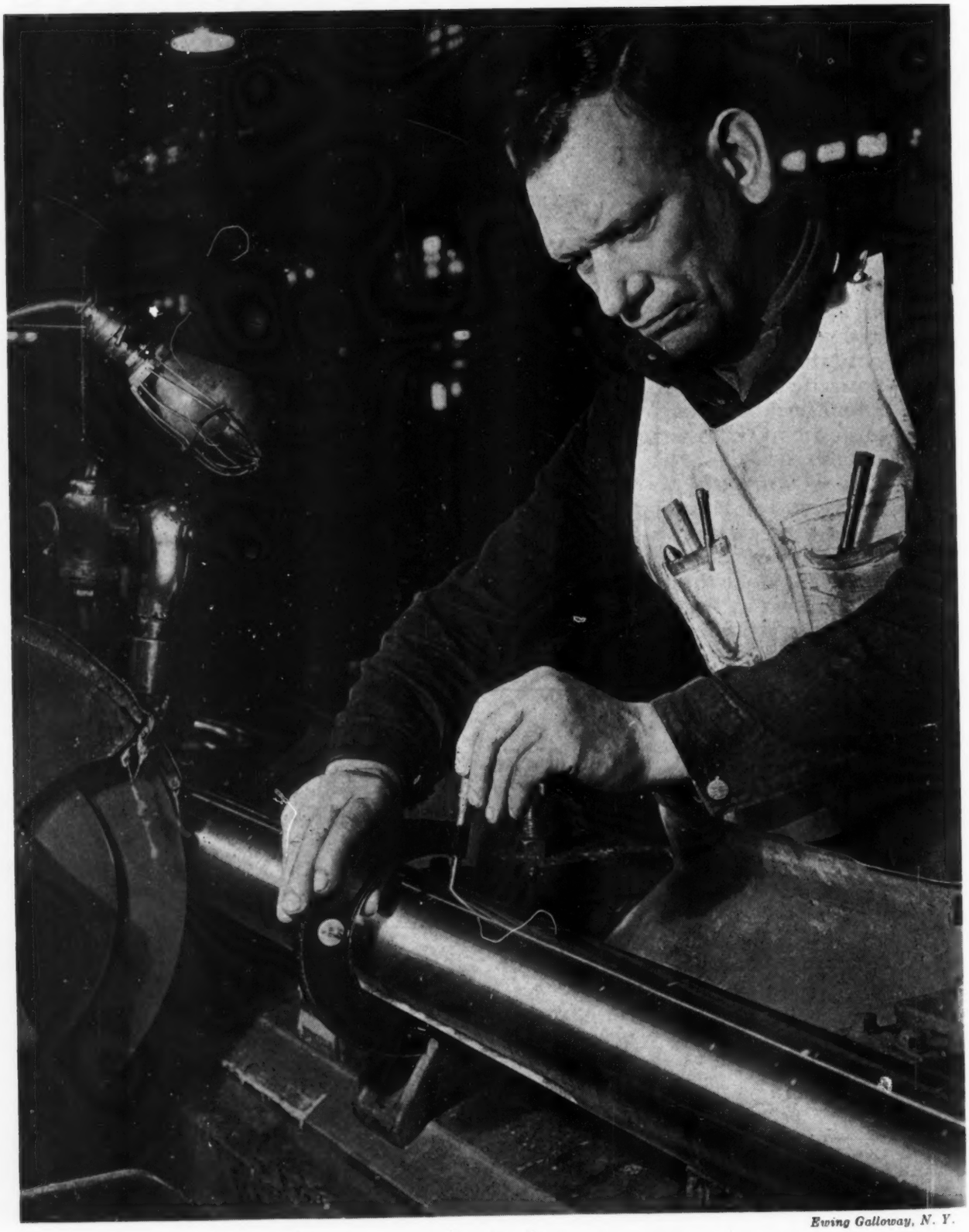

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MARCH
1940

GEORGE A. STETSON, *Editor*

Compensations of Retirement

RETIREMENT, we are reminded by Robins Fleming in the February, 1940, issue of *Civil Engineering*, has its compensations. It comes earlier in the life of an engineer than it once did. Science and technology have seen to that. More of us live to grow up, and more of us live long enough to retire. The pattern of age distribution has suffered changes. What are we going to do about it?

The "ham'n'eggers" have one solution. They would give "thirty dollars every Thursday" to all persons over a certain age on condition that the money be spent within a specified time. Thus money is put into circulation, purchasing and production are stimulated, and everybody has a job, except the older people, who have only the problem of leisure to worry about. They are willing to assume this problem and thus relieve those now unemployed who are unable to cope with it successfully.

Youth also has an answer. If you can't give us jobs, says youth, give us more education. Or it says: You are slow, tired, incompetent; move along and let us fix up the mess you have made of the world.

Many of the middle-aged have solutions. Some would educate youth in the use and discipline of leisure. Some call for shorter hours, for old-age pensions, for recreational facilities, for spread work and made work, for organized amusements, for adult education. Some think in terms of research and more efficient and greater production. Some are concerned with sound and practical schemes of advanced social planning. But the majority are too busy with their jobs, with providing for a family, to do much thinking beyond the day's activities until they finally come face to face with retirement and the problem of what to do about it.

Retirement is no new problem. It is, and always has been, a personal problem. It is becoming more acute as a national problem. In an age in which a majority of men are employed by others and must make their own provisions against its incidence on their lives it comes more suddenly than the old age of feudal and agricultural societies. It finds men with keener intellects and more robust bodies than formerly and for this reason it has more compensations for them. One remembers that Plato had a good word for it and that Macbeth regretted he had forfeited its accompaniments.

Reading what Mr. Fleming has to say about the compensations of retirement one realizes that perhaps the engineer has more to look forward to in retirement than have most people. One notes the idyllic pictures of robust creatures smoking a pipe in shirt sleeves, fishing amid rustic scenery, or at ease on an outward bound steamer, those foresighted persons who, according to the insurance company's advertisements, planned to retire at 55. And then one wonders if these leisurely pursuits of happiness behind a newspaper, on a trout stream, or in a deck chair are not, after all, the occupations of a holiday, even for the retired. Mental activity is the engineer's most characteristic employment. Even in the strenuous years of middle life it forms the pattern of an engineer's diversions. From early age it is the integrating factor that turns tasks into satisfactions. It becomes a habit that retirement need not break. It may not solve the problems of economic misfortune, of loneliness, or of ill-health, but it can blunt their unkind arrows. It would go a long way toward solving a national problem of leisure.

1940 A.S.M.E. Membership List

MEMBERS of The American Society of Mechanical Engineers received in February the 1940 A.S.M.E. Membership List, first to be issued since 1937. Copies were mailed with the February issue of the Transactions to all Society members on the Transactions mailing list. Members not on this list received the Membership List separately. Frequent notice of this method of mailing is made as a reminder to members of the Society whose copies may have bogged down in the mail routine of their offices.

The first section of the 1940 Membership List is given over to the Society Records and is made up of portraits of Society officers and members of the Council, and lists of the Council and committee personnel for 1939-1940. This section is the working directory of persons engaged in Society committee work at the present time. The Society's awards and its past-presidents and honorary members are listed in this section. A convenient and separate index to this section makes it easy to find the personnel of any Society committee.

As usual, the Membership List proper comprises an alphabetical and a geographical list of members. A new feature of the geographical list is the inclusion of certain key letters by means of which the member's interest in the numerous professional divisions is indicated. The key letters will be found only in cases where the member indicated his interest in the divisions by checking the card sent him last fall when information for the 1940 Membership List was assembled.

A new feature of the 1940 Membership List is the Pro-

fessional Service Index, which is made up of a geographical list and a classified specialty list. The index, which contains about 700 names, is confined to "consultants established either as individuals or connected with consulting organizations and is made up of consulting engineers, management consultants, specialists, patent attorneys, and agents, constructors, and contractors." The names in this index were assembled from special reply cards that were sent to all members last fall. If a member engaged in any of these professional services failed to return the card sent him, his name does not appear in the index.

Engineers in Public Life

THE prediction, recently made by Mark Eisner, member of the New York Bar and former chairman of the Board of Higher Education of the City of New York, that "the monopoly on public life long held by lawyers will soon be broken up and engineers will advance to first rank in this field," will be heard with mixed emotions by engineers themselves and by lawyers as well.

A career in public life is, as Mr. Eisner himself pointed out, a natural development of legal practice. This cannot, as yet, be said of an engineering career. Engineers do, as citizens, perform public services in their own communities and, because of their knowledge of many practical matters—for this is an engineering civilization in which we live—their value to the public is of a high order. Some engineers, indeed, have been elected to office in city, state, and the national government, but the engineer as a politician is still rare.

One recalls that Sir Arthur Salter, some time ago, expressed concern over the complications that were being introduced into our public services in such variety and extent that the competence of democratically elected persons to cope with them successfully was to be questioned. In so far as these complications have their origin in engineering developments, the election of engineers to legislative and executive branches of the government would be helpful, if the engineers could remain in office long enough to execute their plans. But it would be necessary to demonstrate that the importance of problems in government arising out of engineering were paramount before it could be argued that engineers should be placed in government merely because of this fact, unless it could also be shown that engineers may have qualifications other than a special technical knowledge. Such a qualification may be found in the engineer's methods of thought and work. Time and again it has been demonstrated that these methods are of almost universal application. Where they may be thought to have failed, and some instance of failure or of questioned success are well known, analysis shows that the failure was not of the methods but of their application. This, indeed, is, as usual, the great hazard; it is the *little* knowledge that is the dangerous thing.

Fortunately, our engineering schools, and, it may be added, our engineering societies, are conscious of some of the causes of these failures—those, for example, that spring from narrow views of a highly trained technician who may attempt to apply his superior, but partial, knowledge in fields where much broader knowledge, particularly of people and economics, is also necessary. These schools are training men who eventually command large numbers of workers in industrial enterprises, and who guide not only technical but administrative, financial, and human-relations policies as well. It is this kind of training and the experiences connected with its application that are needed by wise and competent public servants. It is this kind of an engineer who would be best fitted to take those positions that, according to Mr. Eisner, are to be abdicated by the lawyer in favor of the engineer.

More than competence to fill positions of public service will be necessary to make good Mr. Eisner's prediction. Competence must be joined with a willingness to serve. Beyond that, as Dr. McClellan has pointed out time and again, it will be necessary for engineers to put themselves forward as candidates for the public services. Only in rare instances are bodies of citizens going to draft engineers. It may very well be that engineers, as a rule, have more to sacrifice and less to gain than lawyers in entering public life. For example, it may not be easy for a "lame duck" engineer-statesman to reestablish himself in engineering pursuits following an unfortunate turn of the political wheel. And would a congress made up of engineers please the country more frequently than does a congress made up of lawyers? We can only guess because we have never tried the experiment.

It is characteristic of every profession to assume that it has particular and superior qualities. Lawyers will tell you that their broad concerns with cases in every field of human activity gives them an especial competence in the understanding of human needs and superior judgment in decisions affecting the public interest. Knowledge of man's laws may be more useful than knowledge of nature's laws. Large corporations are likely to choose an administrative head out of the legal profession. Perhaps the lawyers will not abdicate without putting up a good fight. Undoubtedly, engineers would still feel the need of their cooperation and knowledge.

Finally, the question of abdication and succession is going to be settled at the polls. It is conceivable that change of taste in legislators may depose the lawyer and enthrone the engineer. Much depends on public education, on technological subjects and the objective methods of the engineer, and much on the desire and initiative of engineers seeking public service. With the spread of the engineer's methods of thinking among the public, the demand of the public to be represented by men accustomed to those methods will grow. In the meantime it is to be hoped that engineers will continue to increase their understanding of those less technical phases of their profession that bear particularly on public questions and on the technique of convincing their fellow citizens to have confidence in engineering leadership. If they so continue the value of their services will be increased not only in private but in public life as well.

SUPERPRESSED PLYWOOD

Bonded With Thermosetting Synthetic-Resin Adhesives

By R. K. BERNHARD,[1] THOMAS D. PERRY,[2] AND E. G. STERN[3]

THE last few years have witnessed a marked broadening of activity in the plywood field. Hot-pressed synthetic-resin adhesives have revealed many new water- and weatherproof uses from which plywood had been barred by the limitations of other glues. Superpressed plywood, as outlined in this paper, assures the opening of still further possibilities in industries where plywood has never been considered. It is now becoming practicable to take ordinary veneers of a suitable thickness, using a hot-pressing technique, and produce plywood of higher strengths, which can be predetermined with a fair degree of accuracy. Just as metals can be alloyed, tempered, treated, and strengthened, so can wood be improved by this process.

This paper describes and summarizes a series of tests to determine the principles involved in fabricating such superpressed plywood in a practical and economical manner. While much remains to be done in further testing, this superpressed plywood opens new possibilities for the plywood industry.

* * * *

Plywood has become well established as a product with a strength-weight ratio above that of solid wood. Its many strength qualities have been fully described elsewhere (1).[4] One of these qualities is the effect of alternate cross layers which reduces substantially splitting of the wood, thus producing approximately equal resistance to failure in all directions, such as is common to sheets of metals and various synthetic fiber and plastic products.

TYPES OF PLYWOOD

Standard Plywood, Cold-Pressed. Until recently, plywood strength has been based upon the approximate density of normal solid wood. The pressures used in manufacturing plywood were only sufficient to bring the surfaces into intimate contact, thus producing a structural member in which each layer possessed little more than its normal strength, yet the arrangement of the layers resulted in a favorable distribution of the stresses. Obviously, the adhesive had its function in holding the layers together. The succession of the recognized standard adhesives—animal, cassava, casein, soyabean, and others—each had its qualities of strength, water resistance, practical and simple manufacture, cheapness, and the like. All were water solutions and were set or hardened under pressure or in clamps for a matter of hours, without heat. Thus, the final adhesion was the result of the evaporation of the solvent, or its diffusion into the wood layers.

Hot-Pressed Resin Plywood. With the advent a few years ago of synthetic-resin adhesives, thermosetting in character, the time of adhesion (polymerization of the resin under adequate pressure) was reduced from hours to minutes, with temperatures from 200 to 300 F. This resulted not only in substantial savings in time and floor space, but also contributed a new quality, since synthetic-resin bonds gave greater water resistance than any of the cold-set liquid glues previously mentioned. Also, the types of resins used for adhesives are nontoxic and are not attacked by fungus growths. In the case of phenolformaldehyde-resin plywoods waterproofness is so complete that, for instance, after four years of exposure to Florida weather no evidence of solubility or weakness was found in the adhesive, although the wood showed signs of decay.

The substitution of the new heat-reactive synthetic-resin adhesives for the glues used hitherto is steadily proceeding in the plywood industry, even though the new technique requires substantial investment in equipment. The cost of the better resin bonds is entirely consistent with their durability, and the cost of the average-grade resin bond approaches closely that of the cold-pressed glues, while retaining superior durability.

Hot-pressed resin adhesives require slightly more pressure than cold-setting glues. Yet the original density of the normal solid wood is not altered to any great extent. The resin bond employing heat was found to be more reliable and sturdy. Fewer hazards were encountered in obtaining uniform and dependable strength factors.

Superpressed Resin Plywood. The introduction of the improved adhesive material made possible another forward step, i.e., the increase of the density of the wood layers of plywood products by using higher specific pressures. Hitherto, pressures had seldom exceeded 200 lb per sq in., so that the total compression of the wood, or the reduction in thickness, rarely went beyond 10 per cent and was usually much less. The possibility and practicability of increasing these pressures to 500, 1000, or 1500 lb per sq in. opened a field for investigation as to resulting greater density, strength increments in various directions, and improved durability under various types of service. While this field of investigation might be extended to plywood manufactured under even higher pressures, the available equipment limited the scope of the investigation. Yet, the experience gained in this preliminary study may prove to be a guide in the later developments and for further research.

A considerable amount of literature is available on the subject, both in this country and in Europe, as may be noted from the bibliography at the end of this paper. In the main, these papers describe highly specialized individual projects, and do not afford a perspective of the problem, with a development of the basic principles that underlie the subject. This paper is confined to such basic principles.

EXTENT OF THE STUDY

In a series of preliminary tests it was determined to study the effects of the different major variables, keeping in mind the reasonable availability of the raw material and necessary equipment, as well as such cost factors as would make the product attractive to industry. Hence, common species of wood were used in thicknesses that were easily obtainable.

Careful consideration was given to the type of thermosetting

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[4] Numbers in parentheses refer to the Bibliography at the end of the paper.

Presented at the Twelfth National Meeting, Boston, Mass., Oct. 12–13, 1939, of the Wood Industries Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

synthetic resin and to the method of its application. The phenolformaldehyde type was chosen because of its proved durability under many conditions. The reason for selecting the film type, in preference to the liquid form, was its simplicity of application and the ease of control as to the amount used. It was noted that increasing the moisture content of the wood results in more thickness reduction under compression. The use of any liquid adhesive would inevitably add moisture to the wood and involve an uncertain variable that might be difficult to regulate in practice.

Major Variables Considered. The following major variables and the determination of their effects were considered:

1 Thickness of veneer layers, $^1/_8$ to $^1/_{48}$ in.
2 Common species of wood, such as birch, yellow poplar, and red gum.
3 Increasing pressures, 200 to 1500 lb per sq in.
4 Number of layers of resin film, one to three.
5 Number of cross layers, alternate, every fifth and every tenth.

When the influence of the foregoing variables was determined, it was possible to develop, in a preliminary form, comparative tabulations, viz.:

6 Comparison of equally dense plywood of different species.
7 Method of determining strength factors for design purposes.
8 Comparison of superpressed plywood with extra dense solid woods.

The different constructions selected will be noted in the tables. In the interests of simplification, some intermediate stages were omitted, but in all cases maximum, minimum, and one or more intermediates were used.

PLYWOOD FABRICATION

Veneers were rotary-cut or sliced, standard-grade, clear, and without physical defects such as knots and splits. The veneers were assembled and the plywood hot-pressed under normal factory conditions of temperature and humidity, so that all veneer contained from 7 to 10 per cent moisture content. The bonding temperature was 300 F ± 5 deg. Sufficient sheets of veneer were used so that the resulting plywood would slightly exceed 1 in. in final thickness after pressing. Bonding time was 30 min under full temperature and pressure. All series of samples, except two so indicated, were made of an odd number of plies, with each adjacent sheet at right angles to its neighbor, the customary standard plywood construction. The two special series of samples had five (or ten) parallel layers, then one crossed, followed by five (or ten) parallel, etc., the parallel layers being outside on both faces and back to preserve balance. All series of samples were made with single layers of resin film, except one group, where double and triple layers were used.

Certain of the samples, indicated by footnotes in the tables, were cooled under pressure by circulating cold water through the press platens, instead of steam, for 15 minutes. This procedure caused no significant difference in strength values, but was found to secure more uniform thickness of the panels than when air-cooled after removal from the press.

Birch was used for most of the tests, since it has been extensively used as a comparative standard at the Forest Products Laboratory at Madison, Wis. A few samples of yellow poplar and red gum, all easily obtainable veneer woods, were tested also.

TEST PROCEDURE

The samples of superpressed resin plywood were cut into convenient sizes for the testing machine, as shown in Fig. 1. From three to six samples were tested in every series and the results averaged. Tests were made in compression, tension, and shear, the latter both parallel and perpendicular to the grain of the face veneers. Test samples after rupture are shown in Figs. 2, 3, and 4. Since it was found that the two shear tests gave substantially equal results, they are averaged in the accompanying tables. All results are expressed in pounds per square inch. The figures given are those obtained for the maximum loads at the breaking points. The data for solid wood were taken from the "Wood Handbook" (2). They indicate stresses in pounds per square inch at the proportional limit. The shear values shown in solid wood were parallel to the grain, the weakest direction. These solid-wood strength values are used as basic data from which to compute strength increments.

In the light of the experience which has been gained in this preliminary series, additional tests remain to be made, such, for example, as transverse bending, torsion, impact, creep, and hardness.

TEST RESULTS

Effect of Thickness of Veneer Layers. Tests were performed on $^1/_8$, $^1/_{16}$, and $^1/_{48}$-in. birch, all alternate cross-layered, with specific pressures of 500 lb per sq in. It may be concluded that substantial strength increments cannot be expected in either $^1/_8$ or $^1/_{16}$-in. veneer, but are found in $^1/_{48}$-in. veneer constructions, as shown in Table 1. Part of this increased strength may be caused by the greater number of veneer and resin-film layers. It is to be anticipated that $^1/_{32}$ and $^1/_{40}$-strength values could be approximately interpolated in Fig. 5 until more detailed information is available.

Effect on Common Species. This series of tests was made on three common veneer species, birch, yellow poplar, and red gum, the results of which are given in Table 2. Available

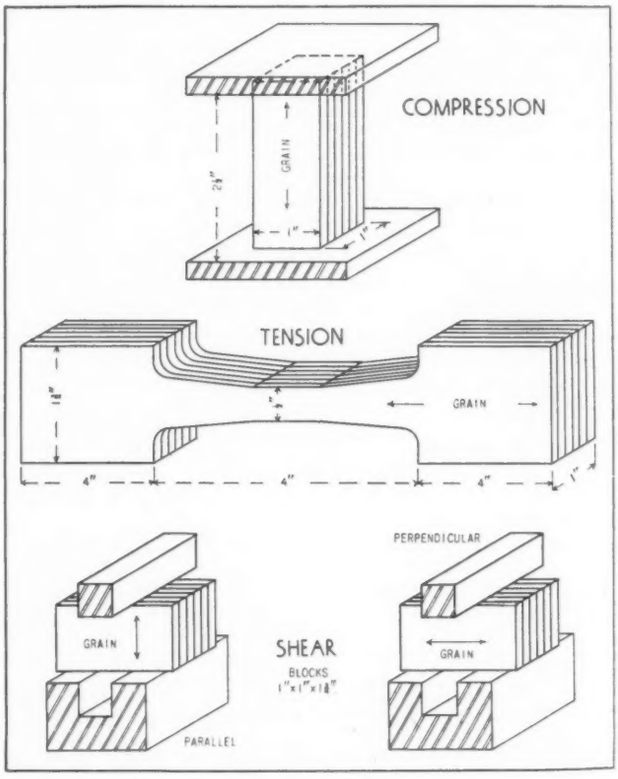

FIG. 1 COMPRESSION, TENSION, AND SHEAR PLYWOOD TEST SPECIMENS

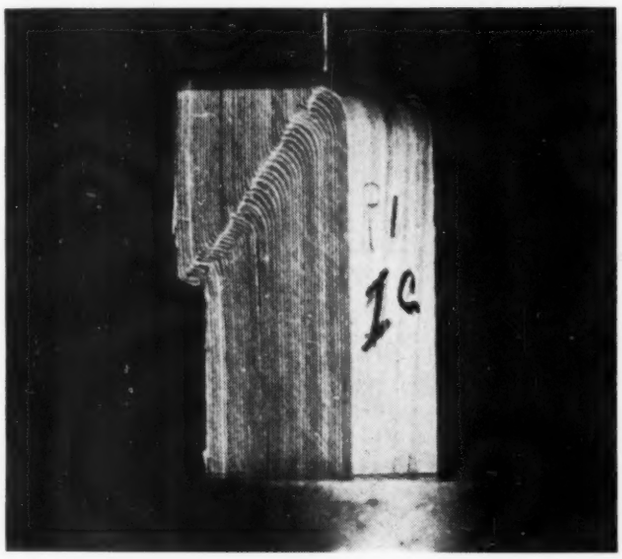

FIG. 2 COMPRESSION SPECIMEN OF 85/48-IN. BIRCH AFTER FAILURE
(Specific pressure = 1500 lb per sq in.)

FIG. 3 COMPRESSION SPECIMEN OF 81/48-IN. BIRCH AFTER FAILURE
(Specific pressure = 1000 lb per sq in.)

thicknesses were $^1/_{48}$, $^1/_{45}$, and $^1/_{40}$ in., respectively. Specific pressure was 500 lb per sq in. with alternate cross layers.

The low initial density of poplar provides an opportunity for greater relative increase in strength than is possible with the denser species, but ultimate strength is indicated to be far below birch and definitely above gum. The results are low on gum, possibly caused by the greater thickness of the veneers. At the pressure of 500 lb per sq in. during the manufacture of the plywood, neither poplar nor gum approach birch in strength, but poplar on a relative basis with birch is closer than in solid wood. Gum, on the other hand, exhibits a reverse tendency.

Effect of Increasing Pressures. These tests were on $^1/_{48}$-in. birch and $^1/_{45}$-in. yellow poplar, with pressures increasing from 200 to 1500 lb per sq in., all alternate cross-layered. In this series an opportunity was afforded to observe a slight difference in strengths between air-cooled and pressure-cooled specimens.

TABLE 1 EFFECT OF VENEER THICKNESS

	Construction	Specific gravity	Moisture content, per cent	Compression, lb per sq in.	Tension, lb per sq in.	Shear, lb per sq in.
A	Solid birch.....	0.63	12.0	6200	10100	2020
B	9/8-in. birch.....	0.77	6.3	7890	11840	6060
C	17/16-in. birch.....	0.72	5.9	7980	13920	6330
D	69/48-in. birch[a]....	1.05	7.7	11720	19160	11540
	Increase *D/A*, per cent.....	67	..	89	90	470

[a] Cooled 15 min under pressure.

TABLE 2 RESULTS ON COMMON SPECIES

	Construction	Specific gravity	Moisture content, per cent	Compression, lb per sq in.	Tension, lb per sq in.	Shear, lb per sq in.
A	Solid poplar.....	0.40	12.0	3550	6100	1100
B	77/45-in. poplar[a]..	0.82	5.3	8460	13420	8220
	Increase *B/A*, per cent.....	105	..	138	120	647
C	Solid gum.....	0.49	12.0	4700	8100	1610
D	45/40-in. gum.....	0.73	6.9	6920	11330	6610
	Increase *D/C*, per cent.....	49	..	47	40	310
E	Solid birch.....	0.63	12.0	6200	10100	2020
F	69/48-in. birch[a]....	1.05	7.7	11720	19160	11540
	Increase *F/E*, per cent.....	67	..	89	90	470

[a] Cooled 15 min under pressure.

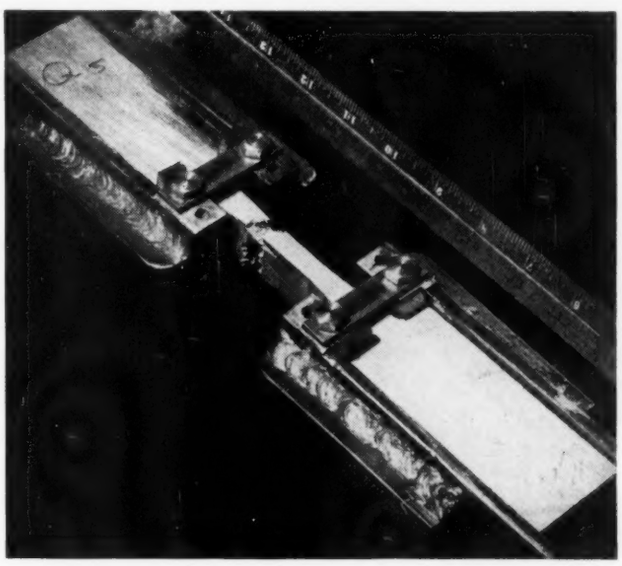

FIG. 4 TENSION SPECIMEN OF 81/48-IN. BIRCH AFTER FAILURE
(Specific pressure = 1000 lb per sq in.)

The features of this series are given in Table No. 3. It is significant that in birch strengths increase slowly above 1000 lb pressure. There is a small gain, most marked in tension. Such further increases may be expected above 1500 lb. The percentages of increased strengths are shown in several ways:

E/A = the ratio of 1500 lb pressure over solid wood
E/B = actual tested strength increments of superpressed plywood at 1500 lb over normal plywood at 200 lb. This is an indication of trends that may be expected in this high-pressure technique
D/B = the same as E/B, but between 1000 lb and 200 lb.

While additional layers of veneer and film are required for the

TABLE 3 EFFECT OF INCREASING PRESSURES

	Construction	Specific gravity	Moisture content, per cent	Specific pressure, lb per sq in.	Compression, lb per sq in.	Tension, lb per sq in.	Shear, lb per sq in.
A	Solid birch	0.63	12.0	..	6200	10100	2020
B	57/48-in. birch	0.77	6.6	200	8580	12550	7240
C	69/48-in. birch[a]	1.05	7.7	500	11720	19160	11540
D	81/48-in. birch[a]	1.30	8.3	1000	14220	25740	16180
E	85/48-in. birch[a]	1.36	8.7	1500	14270	28490	15910
F	85/48-in. birch	1.35	8.2	1500	14540	25030	16360
	Increase *E*/*A*, per cent	116	..	..	131	182	688
	Increase *E*/*B*, per cent	77	..	..	66	127	120
	Increase *D*/*B*, per cent	69	..	..	66	105	123
G	Solid poplar	0.40	12.0	..	3550	6100	1100
H	77/45-in. poplar[a]	0.82	5.3	500	8460	13420	8220
I	105/45-in. poplar[a]	1.32	7.7	1500	14540	23570	16460
	Increase *I*/*G*, per cent	230	..	..	310	286	1396

[a] Cooled 15 min under pressure.

TABLE 4 EFFECT OF LAYERS OF FILM

Construction	Specific gravity	Moisture content, per cent	Film layers	Compression, lb per sq in.	Tension, lb per sq in.	Shear, lb per sq in.
69/48-in. birch[a]	1.050	7.7	Single	11720	19160	11540
73/48-in. birch[a]	1.105	6.9	Double	13300	19800	14520
63/48-in. birch	1.050	6.3	Triple	12590	16930	12280

[a] Cooled 15 min under pressure.

TABLE 5 EFFECT OF NUMBER OF CROSS LAYERS

Construction	Specific gravity	Moisture content, per cent	Number of cross layers	Compression, lb per sq in.	Tension, lb per sq in.	Shear, lb per sq in.
69/48-in. birch[a]	1.05	7.7	Alternate	11720	19160	11540
67/48-in. birch	0.88	7.3	Every 5th	12130	19370	8480
67/48-in. birch	0.89	7.7	Every 10th	13040	19920	8370

[a] Cooled 15 min under pressure.

TABLE 6 COMPARISON OF EQUAL-DENSITY PLYWOOD

Construction	Specific gravity	Moisture content, per cent	Specific pressure, lb per sq in.	Compression, lb per sq in.	Tension, lb per sq in.	Shear, lb per sq in.
81/48-in. birch[a]	1.30	8.3	1000	14220	25740	16180
85/48-in. birch[a]	1.36	8.7	1500	14270	28490	15910
85/48-in. birch	1.35	8.2	1500	14540	25030	16360
105/45-in. poplar[a]	1.32	7.7	1500	14540	23570	16460
57/48-in. birch	0.77	6.6	200	8580	12550	7240
77/45-in. poplar[a]	0.82	5.3	500	8460	13420	8220

[a] Cooled 15 min under pressure.

Reference, Table 3	*E*/*B*	*D*/*B*
Pressure ratio	1500/200	1000/200
Extra material required, per cent	50(85:57)	42(81:57)
Specific-gravity increase, per cent	77	69
Compressive-strength increase, per cent	66	66
Tensile-strength increase, per cent	127	105
Shear-strength increase, per cent	120	123

higher pressures, to secure the same final thickness, this percentage of increased initial bulk and cost is distinctly less than the strength increments, viz.:

Equipment costs at 1000 lb are nearly double those at 200 lb. Increased equipment costs above 1000 lb are considerably more. From a commercial standpoint, it would appear that this limit of 1000 lb provides a reasonable product cost, with outstanding strength values.

It is to be noted that the strength values of birch and poplar are far apart at 500 lb, but are close together at 1500 lb. More poplar layers are required for a given ultimate thickness than in birch, because of greater compressibility. Yet, the availability of the different species in the manufacturing area may influence the economic aspects.

The result of intermediate pressures can be reasonably interpolated from Fig. 6 until more comprehensive data are available.

Effect of One, Two, or Three Layers of Resin Film. This series at 500 lb pressure, performed on $^1/_{48}$-in. birch, with alternate cross layers, indicated the results shown in Table 4. It is the only series of tests in which more than one layer of film was used.

Three layers are better than one, except in tension, while two layers of film between veneers seem to be much better than one. The first combination, however, does not appear to have any special advantages. There is a possibility that tests with multiple layers of film with thicker veneers may modify this conclusion.

Number of Cross Layers. Samples for this series were made of $^1/_{48}$-in. birch, under 500 lb pressure, with cross layers as indicated in Table 5. It is the only series where standard cross layering was not followed.

The slight increase of tensile and compressive strength, caused by the higher proportion of lengthwise layers, is consistent but not significant. The loss in shear strength could be expected.

Comparison of Equal-Density Plywood. Some of the series of tests to determine the effect of major variables indicated the similarity of strength values in constructions of approximately the same specific gravity, as shown in Table 6. As far as comparisons were available, the evidence points toward a consistent and close relation between specific gravity and tensile, compressive, and shear values, both in birch and yellow poplar. All samples cited in Table 6 were alternate cross-layered with single layers of film. How far this consistency may extend into other species, such as soft woods (conifers), as well as those with different thickness of veneer, remains to be investigated.

Method of Predetermining Strength Factors for Design Purposes. The strength factors of the various constructions, segregated according to tension, compression, and shear, can be arranged in tabular form, as in Table 7, indicating the type of construction that will provide the necessary strength. With a later and more comprehensive series of tests on plywood of different species and thickness of veneers and varying pressures, many intermediate strength factors can be made available. With such a table, designers can select the construction, species, thickness, and pressure that will most economically meet the immediate problem.

Comparison With Extra-Dense Solid Woods. Certain extra-dense woods with high specific gravity have a rather limited use. Ordinarily, such woods are available only in small sizes, many of them are imported, all of them are difficult to dry without serious checking, and the cost is often unreasonably high. The proportions of a well-designed superpressed plywood construction may be predetermined and the product be made available in relatively large sizes. Prompt delivery and adequate dimensions will usually offset any moderate cost differentials. In the case of some solid woods, with unusual qualities, such as the oil content of lignum vitae for bearings, due allowance may be made.

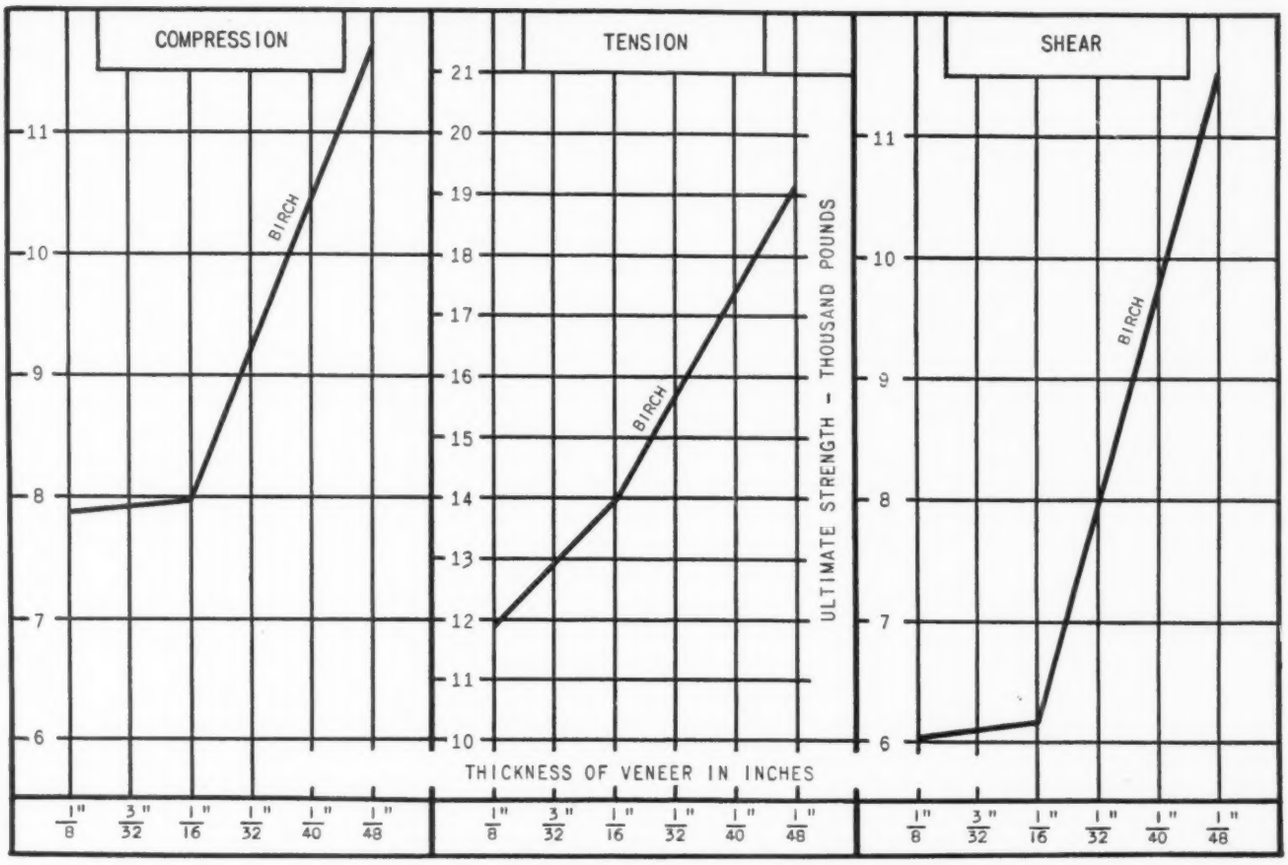

FIG. 5 STRENGTH INCREMENTS OF VENEER THICKNESSES

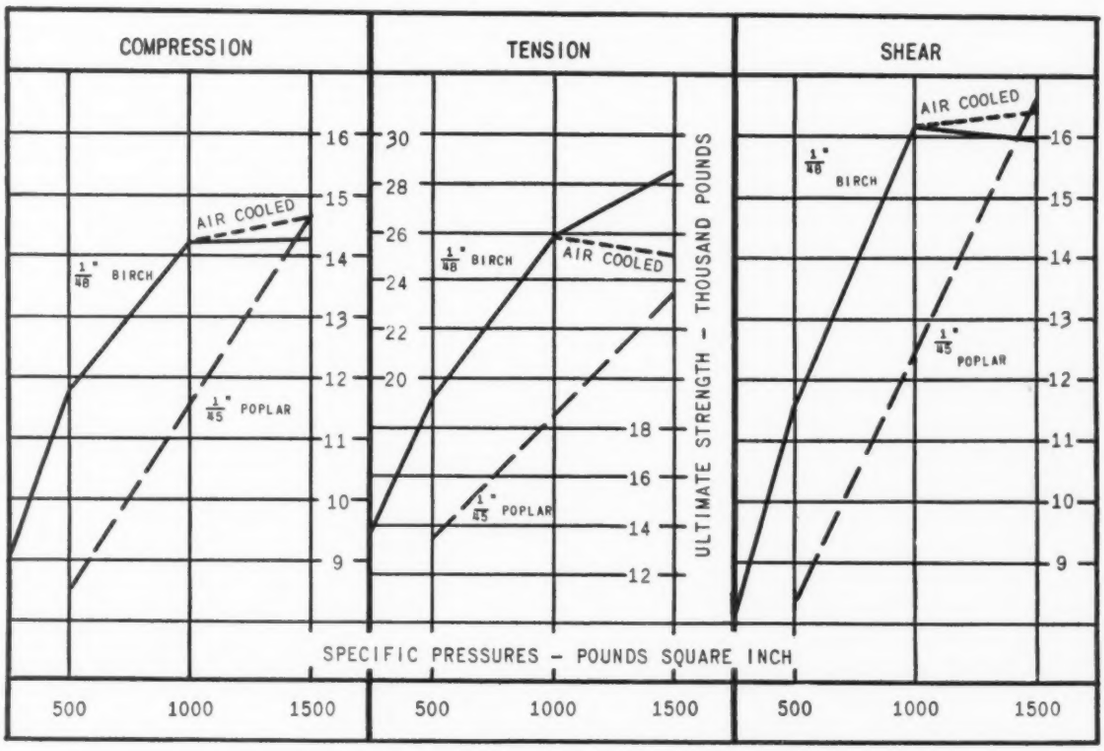

FIG. 6 STRENGTH VALUES OF PLYWOOD AT VARIOUS BONDING PRESSURES

TABLE 7 PREDETERMINATION OF STRENGTH VALUES OF SUPERPRESSED BIRCH PLYWOOD

Type of stress	Veneer thickness, in.	Cross layers	Film layers	Specific pressure, lb per sq in.	Strength values, lb per sq in.	Notes
Compressive	1/8	Alternate	Single	500	7890	
	1/16	Alternate	Single	500	7980	
	1/48	Alternate	Single	200	8580	
	1/48	Alternate	Single	500	11720	2
	1/48	Every 5th	Single	500	12130	3
	1/48	Every 10th	Single	500	13040	3
	1/48	Alternate	Double	500	13300	
	1/48	Alternate	Single	1000	14220	
	1/48	Alternate	Single	1500	14540	1
Tensile	1/8	Alternate	Single	500	11840	
	1/48	Alternate	Single	200	12550	
	1/16	Alternate	Single	500	13920	
	1/48	Alternate	Single	500	19160	2
	1/48	Every 5th	Single	500	19370	3
	1/48	Alternate	Double	500	19800	
	1/48	Every 10th	Single	500	19920	3
	1/48	Alternate	Single	1000	25740	
	1/48	Alternate	Single	1500	28490	1
Shear	1/8	Alternate	Single	500	6060	
	1/16	Alternate	Single	500	6330	
	1/48	Alternate	Single	200	7240	
	1/48	Every 10th	Single	500	8370	3
	1/48	Every 5th	Single	500	8480	3
	1/48	Alternate	Single	500	11540	2
	1/48	Alternate	Double	500	14520	
	1/48	Alternate	Single	1000	16180	
	1/48	Alternate	Single	1500	16360	1

NOTES: 1 Increase of pressure, 1000 to 1500 lb per sq in. gives little added strength.
2 Basic Standard of this series of tests.
3 Difference between crossing every fifth and tenth layer not significant.

TABLE 8 EXTRA-DENSE NORMAL SOLID WOODS AND APPROXIMATE EQUIVALENTS IN SUPERPRESSED PLYWOOD

Species	Specific gravity[a] Range	Specific gravity[a] Average
Apple	0.66–0.84	0.75
Beech	0.70–0.90	0.80
Boxwood	0.95–1.16	1.05
Dogwood	0.68–0.77	0.72
Ebony	1.11–1.33	1.22
Hickory	0.62–0.78	0.70
Hornbeam	.....	0.75
Lancewood	0.68–1.00	0.84
Lignum vitae	1.17–1.33	1.25
White oak	0.69–0.86	0.77
Satinwood	.....	0.95
Teak	0.66–0.98	0.82

Construction[b]	Film layers	Specific pressure, lb per sq in.	Specific gravity
17/16-in. birch plywood	Single	500	0.72
45/40-in. gum plywood	Single	500	0.73
57/48-in. birch plywood	Single	200	0.77
77/45-in. poplar plywood	Single	500	0.82
69/48-in. birch plywood	Single	500	1.05
73/48-in. birch plywood	Double	500	1.105
81/48-in. birch plywood	Single	1000	1.30
105/45-in. poplar plywood	Single	1500	1.32
85/48-in. birch plywood	Single	1500	1.36

[a] Specific gravity from Kent's Handbook, 1938 edition.
[b] All constructions standard alternate crossings.

Several high-specific-gravity woods are shown in Table 8, as well as superpressed plywood, for the purpose of comparison.

COMMERCIAL APPLICATION

In spite of the fact that the sources of supply for superpressed plywood have hitherto been limited, and its strength data were not available in convenient reference form, its utilization gives evidence of certain commercial possibilities. Following are a few applications for superpressed plywood.

Airplane Propellers. Propellers require dense sturdy material for higher strength near the hub, with lighter material toward the rapidly revolving tip to reduce the centrifugal forces. Two methods of construction are under development. First, scarfing together members of different-density wood in approximately 1/2-in. layers, very dense plywood near the hub and very light plywood toward the tip. Second, variable-density plywood can be made in layers of similar thickness, using more sheets of veneer near the hub where compression will obviously be greater, and fewer sheets near the tip where only enough pressure is required to make complete surface contact. These layers of either type are assembled into squares from which the propeller is machined (16, 17, 19, 22).

General Aircraft Construction. Thin plywood for wing coverings, molded plywood for fuselages, hollow plywood beams, and superpressed plywood for braces, webs, ribs, and the like. There is a distinct trend toward a return to plywood in many airplane parts, because of the availability of machinery and skilled workmen in the woodworking trades (5, 6, 9, 10, 13,16).

Forming Dies for Thin Metal Sheets. Plywood can be used for dies which can easily be worked with ordinary woodworking tools. Plywood provides a more easily machined material for forming dies. This method encourages speed and low cost in die construction without sacrifice in quality of formed metal (14).

Gears. Plywood gears are made with veneer laid in rotation, 15, 30, or 45-deg angles between adjacent layers. This star-shaped arrangement of layers provides a substantial proportion of strong end-grain wood with fibers in a radial direction to provide maximum strength (17).

Gusset Plates. Plywood has applications as gusset-plate material for joints of timber structures and webs for plate girders.

Die-Cutting Blocks. Softer species with high pressures can be made available as a substitute for such hard woods as maple and beech.

Textile Machinery. Many parts of these machines and their accessories must be light in weight and yet are subjected to excessive wear. The difficulties of quickly obtaining adequate-size stock in such dense woods as lignum vitae, ebony, persimmon, dogwood, and hickory will increase the interest in plywood in which strength and density characteristics can be approximately predetermined.

Other Items. Plywood can be used for such items as gun stocks, sporting goods, and handles for various purposes.

CONCLUSIONS

1 The veneer thickness of superpressed plywood influences its strength substantially. Plywood panels with thin laminations (1/48 in.) may be recommended in certain cases because of their stronger bond.

2 Neither poplar nor gum plywood approach birch plywood in their strength, if manufactured under a pressure of 500 lb per sq in.

3 However, poplar and birch superpressed plywood have similar high strength values when manufactured under pressures approaching 1500 lb per sq in. The strength increases for the same materials vary between 66 and 127 per cent for plywood made under 200 and 1500 lb per sq in., respectively.

4 The amount of synthetic resin influences the strength of the bond of superpressed plywood.

5 The arrangement of cross layers affects the strength data to such an extent that consideration should be given to this factor when the material is used for specific purposes.

6 The strength of superpressed plywood seems to increase in direct proportion to its density.

7 The strength of superpressed plywood may be adapted to its proposed function, because its strengths can be predetermined with a fair degree of accuracy.

8 Compared with extra-dense solid woods, superpressed plywood seems to have certain advantages.

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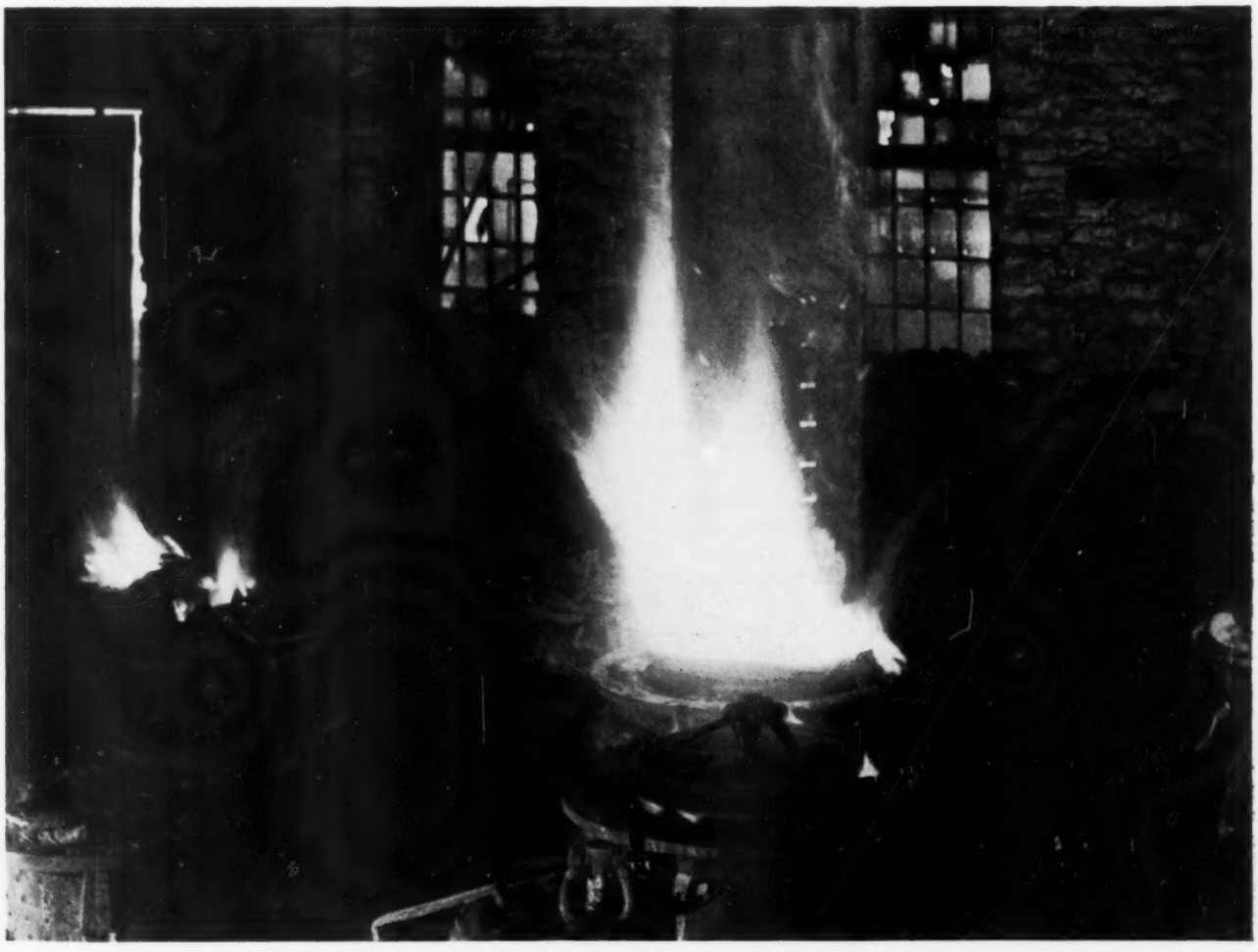

REMOVING CORE BAR FROM MOLD IN A PIPE FOUNDRY

(Photograph taken by H. A. Hoffer and shown at the Fourth Annual Photographic Exhibit held during the A.S.M.E. Annual Meeting in Philadelphia, Pa., Dec. 4–8, 1939.)

RESEARCH *and* INVENTION *in* ENGINEERING COLLEGES

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THE PRACTICE of engineering can only be kept up to date through research. Engineering research has among its major objectives the development by scientific means of new manufactured products, more efficient machines and tools, special mechanisms and devices, improved meters and instruments, better manufacturing processes, and more economical methods of operating equipment. Industries which have made the most spectacular progress are also foremost in research. Research is an integral part of any organization interested in efficiency, in long-range goals, and in linking the present with the future.

No very clear-cut line can be drawn between scientific and engineering research, although the latter is more generally concerned with the results of immediate economic value. It is also difficult to differentiate between research and development.

RESEARCH AT ENGINEERING COLLEGES

Research in higher educational institutions is being supported to a considerable extent by industry and by the government. Industry recognizes that the research specialist at an educational institution is working in an atmosphere which is sympathetic to research and free from interruptions. The efforts of the research worker in an educational institution result not only in new knowledge but also in improving the main product of education, the students. In the past there has always existed a definite gap between the successful completion of a scientific research project and the utilization by industry of the results secured. This gap is being greatly reduced by cooperative research, which brings together most effectively the talents of the university and of industry. There is a constantly increasing amount of research being carried on by American industry in cooperation with educational institutions, research foundations, and government bureaus. The results secured by industry through research, in cooperation with selected engineering colleges, indicate that such educational institutions can undertake and carry out successfully research projects of considerable magnitude, and of benefit to industry as well as to engineering education. From the earliest days of our national existence the United States Government has conducted investigations, of a greater or lesser scientific character, in order to establish a sound basis for its legislative and administrative activities. Investigations in agriculture predominate among the fields of governmental research. Next to agriculture comes research for improved public defense. Outside of the field of agriculture practically no support has been given by the government to research in higher educational institutions.

In 1931, a report[1] was published giving the status of research in engineering colleges during the year 1928–1929. During that year $2,156,863 were expended by the engineering colleges of the United States of America, which made provision for the employment of 575 full-time and of 807 part-time research workers.

The engineering colleges in the "land-grant" group, which represents about one third of the engineering colleges of this country and nearly one half of the engineering-student enrollment, had available during the year 1939–1940 a total of $1,802,263 for engineering research, which was being carried on by 251 full-time and 450 part-time workers, in addition to 383 teachers who were devoting time to research without extra compensation. Of the funds expended for engineering research at the land-grant institutions during 1939–1940, the sum of $962,267 came from industry.

INVENTIONS AND PATENT POLICIES

Reasons for Patent Policies. Research at educational institutions may lead to improved processes, machines, chemical compounds, or articles of manufacture of potential industrial and commercial value. Thus, educational institutions have found it necessary to consider patent policies in order to encourage inventive talent on the part of their staffs and students, to protect industries cooperating with them, but particularly as a protection to the institutions themselves which ordinarily do not have the facilities to administer patents and usually consider legislation and business details in handling patents entirely outside of the jurisdiction of their governing boards. In state-supported institutions, the administration of patents and special payments to inventors often involve legal restrictions. Some state universities take the stand that a state institution supported by public funds has an obligation to reserve for use of the public all benefits accruing from investigations made by its staff members or others under its control. Such institutions reserve the right to all discoveries and inventions which are the direct result of the staff members' regular duties or at the expense of the university. Inventions developed outside of their regular duties or at their own expense are not the property of the university.

Research Foundations. There is a definite trend for universities to turn over their patent problems to the Research Corporation of New York, or to set up research foundations of their own, which finance research and to which the inventor assigns all rights of his research findings. Such institutional research foundations are nonprofit corporations organized for the purpose of encouraging creative talent by relieving the inventor of the financial burden and loss of time from his research interests, and by financing research from profits accruing from the sale or royalty on patents. The charter of such foundations usually includes a clause which authorizes them to accept "all rights and titles to inventions, in order to protect, defend, dispose, and/or arrange for the discovery or invention by members of the staff or students of the institution" affiliated with the foundation. Research foundations are granted by their charters the freedom to accept gifts. Research foundations are in a position to aid educational institutions in sharing patent rights

[1] Supplement to *Journal of Engineering Education*, February, 1931.

Presented at a meeting of the American Association for the Advancement of Science, Section M, held at The Ohio State University, Columbus, Ohio, December 28, 1939.

with industry, a common practice in many industries which even license their direct competitors.

The Research Corporation of New York is the outgrowth of Dr. Cottrell's interest in the development of science and its applications. For a number of years the corporation concerned itself mainly with the development and installation of Cottrell precipitators. However, the field of endeavor of this foundation has been broadened into many scientific fields, and it has taken over the handling of patent problems in educational institutions. The net earnings of this foundation are used to encourage scientific investigation.

The research foundations at universities have usually been developed as the result of an invention by a member of the institutional staff and by reason of the growth of research in cooperation with industry at educational institutions. Thus, the Cornell Research Foundation, Inc., was started after a member of the agricultural staff discovered a patentable process. At Purdue University inventions of commercial value, developed in its agricultural and engineering experiment stations, led to the creation of the Purdue Research Foundation. At Wisconsin several of its alumni became interested in Dr. Harry Steinbock's discoveries relating to the use of ultraviolet rays to enrich the vitamin D content of foods for medicinal products, and the Wisconsin Alumni Research Foundation resulted with its major objectives "to promote, encourage, and aid scientific investigations and research . . . . . and to assist in providing the means and machinery by which scientific discoveries of the staff may be developed and patented, and the public and commercial uses thereof determined."

Former Reports on Patent Policies of Educational Institutions. A committee of the Association of Land-Grant Colleges and Universities on uniform patent practices submitted a report[2] to the American Association for the Advancement of Science, on November 22, 1922. This report includes the following suggestions with reference to patent policies of state institutions:

(*a*) That an institution has a right to inventions or discoveries made by the members of its staff incident to their regular duties or at the expense of the institution.

(*b*) There may be cases where the inventive genius of the investigator, while helped, no doubt, by his surroundings in the experimental laboratory, nevertheless, would have evolved the same idea under circumstances where there would be no question as to it being his property. There would be other cases where, without question, the investigator could not have any moral claim personally to the ownership of the patent. Therefore, it would be rather difficult to make any hard-and-fast rule but what would work some injustice one way or the other. In any case the inventor should have some equity in the patent, but so also should the institution.

(*c*) That the main reason for securing patents on inventions is to prevent an outsider from pirating them at the expense of the public.

(*d*) The possession of a patent implies an obligation to utilize the invention for the benefit of the public. If there is danger that the patent will be filed away "under a bushel" it will be better for the institution to forego its right to inventions.

(*e*) Several were of the opinion that the inventions or discoveries made by members of engineering-experiment-station staffs should be made available to the public without restriction. Alfred D. Flinn, secretary of the Engineering Foundation, brings out the fact: "A patent, given to the public, is often most effectively withheld from the public, because no one would assume the business risk and the development expense necessary to commercialize an article over which he can have no control for a reasonable period." Only patents which have no commercial value may be properly dedicated to the public.

(*f*) The question of disposition of the patents is a most difficult problem to solve. If manufacturing rights were granted to all who apply, responsible business concerns would not be interested. Educational and research institutions are not in a position to do commercial business, such as would be involved in owning patents, to defend the patent owned, or even to negotiate successfully for the disposal of rights under patents. Unbusinesslike methods in handling patents by educational institutions would hinder rather than promote discoveries or inventions. It will be necessary to have some outside organization handle the details with reference to the disposition of the patents. The Research Corporation of New York was organized to handle patents of those who are not in a position to exploit them. In time the various engineering experiment stations may accumulate a sufficient number of patents to justify the organization of a central clearing house for the administration of such patents.

The following is a summary of a publication[3] by Archie MacInnes Palmer on the subject of university patent policies:

"Most of the research conducted at educational institutions, being primarily concerned with the extension of knowledge, is not utilitarian in view. Nevertheless, the efforts of research workers, especially in the applied sciences, frequently result in discoveries of probable, if not immediate, application."

In order that the public may derive the most good from such discoveries the educational institutions should in most cases patent the applicable results of research and direct their commercialization in an unexploitative manner. In very few cases does it seem wise to dedicate a discovery to the public.

Among the legal, administrative, and ethical problems are those involved with the obligations to the public, the inventor, the industrial donor in cooperative research, and the educational institution. The procedures and policies followed by universities in this country in handling these problems vary considerably.

The following patent policies reported in the Palmer bulletin[3] are of interest:

At St. Louis University a faculty-composed Committee on Grants for Research handles patent problems and is authorized to make agreements with licensees, control the standardization of the product being made under the license, and distribute the income from the patents.

At the California Institute of Technology, it is the practice for any staff member, who in connection with his research makes a patentable discovery, to assign the patent to that institution. Such action, however, is taken only when the officers of the Institute think it expedient in the interest of C.I.T. The disposition of any proceeds is left to the board of trustees.

At the University of Toronto the governors of the university have been empowered with all the necessary authority needed for securing and administering patents. The staff member is not forced to assign his rights to the University; the facilities are merely offered staff members for their own volitional use.

At the University of Cincinnati an Institute of Scientific Research was organized in 1920, "to provide a separate unit for research in any distinctive field or for combined research in various fields." Under its management at least three separate research foundations and accompanying research laboratories

[2] Report of Committee on Uniform Patent Practices of the Association of Land-Grant Colleges and Universities, presented at the 76th annual meeting of the American Association for the Advancement of Science, Dec., 1922.

[3] "University Patent Policies," by Archie MacInnes Palmer, *Journal of the Patent Office Society*, vol. 16, Feb., 1934, pp. 96–131.

under university supervision have been set up in specialized fields.

The University of Utah made plans in 1934 for the organization of a research corporation, since the university is prohibited by law from exploiting the fruits of its research.

Present Patent Policies of Educational Institutions. The principal aspects in regard to present patent policies and practices of educational institutions were secured from 39 universities, colleges, and technological institutes, which included 25 state institutions and 14 privately endowed universities and technological institutes. This list was made up of the state universities of California, Florida, Georgia School of Technology, Illinois, Iowa, Iowa State College, Kansas, Kansas State College, Kentucky, Maine, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, North Carolina State College, Ohio, Oregon State College, Pennsylvania State College, Purdue, Texas A.&M. College, Virginia Polytechnic Institute, Washington State College, West Virginia, and Wisconsin. The privately endowed institutions included Carnegie, Case, Columbia, Cornell, Harvard, Lehigh, Massachusetts Institute of Technology, New York University, Pittsburgh, Princeton, Rensselaer Polytechnic Institute, Stanford, Stevens, and Yale.

These aspects may be summarized as follows:

Twelve of the above institutions have no patent policies. These include the Case School of Applied Science, North Carolina State College, Rensselaer Polytechnic Institute, Stevens Institute, and the universities of Iowa, Kansas, Kentucky, Missouri, Nebraska, New Hampshire, Pittsburgh, and West Virginia.

Research foundations have been organized at seven institutions, which include Cornell, Minnesota, Ohio State University, Purdue, Virginia Polytechnic Institute, Washington State College, and Wisconsin. The University of Maine is in the process of adopting a policy which will include a research foundation.

The University of California, Massachusetts Institute of Technology, and Princeton University have arrangements so that all business matters of any invention are handled by the Research Corporation of New York upon the recommendation of an institutional patent committee. New York University has no policy at present but is exploring a modified type of contract with the Research Corporation of New York.

The Carnegie Institute of Technology at Pittsburgh is now formulating a policy for the entire institute; but in its two research divisions, concerned with coal and metal investigations, the research staffs are at present under written agreement to assign all patents to the institute. This requirement does not apply to investigators outside of the coal and metal research laboratories. In the case of the coal research laboratory, patents are held in the name of the Carnegie Institute of Technology and are administered by the institute board of trustees. Patents are licensed to each of the contributing companies without cost until such remission of normal license fee shall amount to twice the total contributions made, or ten times the annual contribution in the year in which the patent is granted, whichever is the greater.

Columbia University in the City of New York has a corporation controlled by a board of trustees which offers its facilities to members of the faculty in securing and administering patents, provided, in the judgment of the board, a patent is desirable in the public interest.

The University of Florida has at present under consideration a patent policy under which patents will be administered by a research council of staff members and applicable to investigations financed by the university or by an agency cooperating with it.

Harvard University is interested only in patents of its staff members which have therapeutic value. Patents of professors outside of the medical faculty of Harvard University are considered to be the private affairs of the inventor.

Iowa State College handles the legal and administrative details through a joint patent committee of the college and the Iowa State Board of Education. A similar policy is found at the Georgia School of Technology where patents of staff members and students are assigned to the Industrial Development Council, a corporation of the State of Georgia which administers patents in its trust.

The University of Illinois controls all patents and under its rules requires the assignment to itself of all discoveries made by members of its staff in the course of their researches as such members, whether the research be financed from private sources or otherwise; all patents thus acquired are controlled by the university. The application for patent is made by the staff member and the patent is assigned to the university, which grants licenses exclusively or nonexclusively, according to the circumstances, and gives preferential consideration to private sources financing a given research. The university deals liberally with the inventor and pays him a substantial portion of the earnings from patents, after all expenses have been paid.

Lehigh University has its staff members assign to the university patents resulting from cooperative research, and the royalties are equitably divided.

The patent policy of the University of Michigan involves the assignment to the regents of the university only of those patent applications with inventions resulting from research projects financed by the university or by some party under contract with the university. The cooperating agency is given a nonexclusive free license to any patentable inventions which it finances. The client, however, may also elect to take full assignment and be responsible for the preparation and prosecution of the application. The university has no incorporated research foundation but handles directly all legal and business details regarding patents.

The Pennsylvania State College requires all staff members engaged specifically to do research to assign to the college all patents resulting from their assigned duties. Other staff members are not so bound by contract, but are advised to assign patents to the college only on the occasion that the council on research judges that the college obviously has an equity in the work from which patents resulted. The college pays the cost of obtaining such patents and the board of trustees may transfer all rights to the Pennsylvania Research Corporation (or similar organization) for administering the patents.

At Stanford University, a patent committee of the institutional faculty and administration receives reports of discoveries by staff members and students. Inventions found valuable are assigned to the university upon the recommendation of the patent committee to the president. When researches are of a cooperative nature, patent interests and rights are shared equitably with the donor in proportion to the relative contributions.

At Yale University, patent matters are referred by the president to the prudential committee of the corporation which is authorized to deal with each case according to its merits.

At the state colleges of Kansas, Oregon, and Texas institutional policies with reference to patents are under consideration.

It is a policy of educational institutions not to acquire inventions other than those developed by its staff members and students.

Arrangements regarding royalties differ. Most institutions have no definite commitments. In some universities a percentage of the gross or of net earnings, 7 to 10 per cent of the gross earnings and 15 to 50 per cent of the net earnings, is paid to the inventor. Each case is treated separately and with par-

ticular care that equitable rewards are accorded to the inventor. At the same time, recognition seems to be given to the fact[4] that "our patent laws were enacted to encourage the development of the industries for the benefit of the public and not to reward the inventor."

Those institutions which issue licenses on their patents usually determine the royalty basis in accordance with the estimated commercial possibilities of the invention, the prevailing rate in industry, whether or not the licensee financed the research project from which the patent resulted, and value of the invention in connection with national defense and general public interest. Few institutions seem to feel that industry has the sole claim on patents resulting from research which it finances. The usual practice is to grant nonexclusive licenses only under conditions and restrictions calculated to produce maximum benefit to the public with due fairness to the industry which financed the research program. In some cases a moderate royalty is expected for use in development and production, as well as a certain amount of control.

Few universities and colleges have any positive policy or interest in participating in cross-licensing or patent pools; only two reported having any connection with a patent pool. Thus, at the Georgia School of Technology, one case of cross-licensing provided for the exclusive handling of licenses by the Industrial Development Council, a state corporation handling the patent problems of that institute. The University of Minnesota has entered into a partnership which might be designated as a patent pool to cover a certain specific field already occupied by a company of national and international importance in the field.

DEFENDING PATENT RIGHTS

There seem to be two different policies regarding patent litigation and the defense of patent rights. Where patents are handled through the research corporation or through a research foundation affiliated with the educational institution, the general policy is to avoid aggressive action but to defend all clear rights even to the extent of court litigation. Some foundations insist in license agreements that the licensee assume the expense (in part, if not all) of patent litigation. When patents are administered by the governing boards of universities and colleges, legal and political implications usually govern the actual procedure. In general, state-supported institutions have to exert great caution in entering into contracts which may lead to court litigation.

Sixteen educational institutions, which have cooperated in this study, report 380 patents of which 114 are in active use. Only one university dedicated an invention to public use mainly because of its simplicity. Only five educational institutions report income from patents.

Patent policies of educational institutions apply to inventions in the public interest, inventions resulting from researches in cooperation with industry, and inventions resulting from research at the expense of the educational institution. No other country in the world offers to creative genius the incentive and opportunity which are afforded by the patent system of the United States of America, provision for which was made 150 years ago in the Constitution of this nation. Our patent system vitalizes and perpetuates the stimulus to invention without which technical progress would have been stifled by secrecy and selfish motives. Without question the patent system of the United States is a major contributing factor to the industrial supremacy of America. American industry is dependent for its future progress upon our patent system which has provided a stimulus to inventors, and a protection to capital which has backed creative effort. Educational institutions cannot expect to secure from industry large sums for research unless the discoveries from such investigations are protected by patents. Industries expect protection from exploitation by their competitors.

There is a general consensus of opinion that commercially valuable discoveries should not be dedicated to the public but should be patented. As Dr. Elihu Thomson has said[5] "Publish an invention freely, and it will almost surely die from lack of interest in its development. . . . . Patent it, and if valuable, it will be taken up and developed into a business."

Among those institutions which have no definite patent policy, there is found in some cases an attitude that an educational institution has no right to become involved in patent business, but that an invention belongs only to the inventor. In many cases authorities feel no need for a special patent policy, either because the researches in such institutions have not yielded results of particular commercial value, or by reason of their interest in theoretical or basic research. In a special publication[4] of the American Association for the Advancement of Science, supplement to *Science*, the objections to patenting, not only by institutions, but also by scientists and professors, were based on ethical and moral grounds as well as interference with research. Those objecting to an interest in patents on the part of scientists claim that patenting requires secrecy on the part of the research worker and leads to the debasement of research and to ill feeling and jealousy on the part of colleagues. On the other hand, the social and economic advantages that accrue from patenting the results of research that have potential commercial and industrial value far overshadow the objections mentioned.

CONCLUSIONS

Educational institutions of higher learning have produced, in their research laboratories, discoveries and inventions of value and importance to industry and agriculture. Not until comparatively recent years, however, have colleges and universities realized that their technical research programs would better serve mankind if commercial and public needs were strongly considered in their planning and if the cooperation of industry were available. In making the products of the laboratory available to society, colleges and universities have found that dedicating the findings of research to the public actually withholds these findings from use. Likewise, industry is very reluctant to invest in cooperative research unless patent rights are obtained for the results of research allowing adequate protection for the commercialization of the new findings. For these reasons it has been found that educational institutions operating their research programs under definite patent policies are in the best position to enhance technical progress.

Formal arrangements with staff members regarding patents usually apply to cases of research programs financed entirely by the university, college, or institute or by some outside agency or donor in connection with cooperative research programs. Inventions not financed by educational institutions or by agencies cooperating with them are the property of the individual teacher or research specialist. Where research foundations have been established, they are available for use by staff members in connection with their own inventions. Equitable sharing of ownership is decided upon in instances where others have a legal right to a share in the new finding. In cooperative research, even if it is financed entirely by industry, the resulting patents are assigned to the educational institution which, in turn, usually shows special consideration to the donor in the matter of licensing. The securing and administer-

[4] Special Publication, American Association for the Advancement of Science, supplement to *Science*, vol. 79, no. 1, Jan., 1934.

[5] "Elihu Thomson Lays Down Principles for Inventors," *Electrical World*, vol. 75, 1920, p. 1505.

ing of patent rights is considered by the governing boards of many institutions to be outside of their jurisdiction and, in state-supported colleges and universities, much caution must be taken in the handling of patent matters to avoid legal difficulties. In meeting this situation, seven of the 39 educational institutions, questioned in the study, have organized research foundations for administering desirable patent policies while one other is planning such action; three have entrusted the handling of patent matters to the Research Corporation of New York and a fourth is considering the adoption of this procedure; in two other instances a state board is given the responsibility for patent administration; patent policies and problems in 13 other educational institutions are under the jurisdiction of faculty committees and/or governing boards. Twelve schools have not as yet organized or have not felt the need of formulating a definite patent policy. Thus about two thirds of the institutions investigated have a definite patent policy, and these include the institutions which receive the greatest support for research from industry. There is apparently no difference in the actual practice of state-supported and privately endowed institutions. Nearly as many have patent matters administered through research foundations, or the Research Corporation of New York, as through institutional governing boards.

Those universities and colleges which have definite patent policies are of the opinion that both the social and economic welfare of the public are being enhanced by their methods of handling patents and of encouraging creative activity of their staff members. Unexploitative commercialization of patents is of definite value to the public. Earnings received from patents are used to reward the inventor and to support research.

The procedure of utilizing the personnel and equipment of educational institutions in cooperative research with industry is sometimes looked upon with doubt and disapproval. Colleges and universities often are prejudiced against cooperative research because of the legal and administrative problems involved, precedent and policy of governing boards, and moral and ethical principles. On the other hand, industry is often skeptical of cooperative research on the grounds that educational institutions are too unbusinesslike, and too theoretical in their research activities. The initiative in bridging the gap between the two groups can be taken by colleges and universities in formulating and administering patent policies designed to remove the difficulties and misunderstandings retarding cooperation between industry and educational institutions.

The fact that the income accruing to educational institutions from patents is insignificant indicates that the incentive for discovery and invention in colleges and universities is not financial reward but is involved in the fair and equitable recognition of creative genius and of aid given by industry to research. Scientific research is the main concern of higher education with reward to the institution and inventor as a secondary consideration. Inventive ability is placed on the same level as good teaching and good relationship with the public, and the creation of new scientific knowledge is recognized and rewarded. Industries cooperating with educational institutions find that a considerable number of colleges and universities through a sound patent policy are in a position to protect the findings of the research laboratory, while encouraging creative talent and reward for accomplishment.

Cushing, New York

TO GO INTO SERVICE ON THE MISSISSIPPI

(A streamlined all-welded steel excursion steamboat, 374 feet long, to go into service this summer on the Mississippi River. Two of its decks are glass-enclosed and air-conditioned. Its steel hull has 74 watertight compartments. Two 1500-hp oil-burning engines propel side paddle wheels.)

AIMS *and* RESPONSIBILITIES *of* MANAGEMENT TODAY

By HOWARD COONLEY

CHAIRMAN OF THE BOARD, NATIONAL ASSOCIATION OF MANUFACTURERS

DURING the forty years of my business life I have seen industry develop from a simple and comparatively intimate activity to one of great complexity and difficulty.

At the turn of the century, industry was made up largely of small units with modest organizations. The chief executive, or boss as he was then called, was brought into close contact with his employees, and called most of them by their first name. That same boss, in all probability, took an active part in the management of his plant and knew most of his customers and suppliers intimately. His distribution was largely confined to a small radius. His stockholders were few, usually his intimates.

The amazing changes in the following four decades were a natural consequence of world changes, the broadening of territories, the demand for better products at lower prices, and the consequent requirement of unusual and costly services. Mass production requiring huge financial investment and, therefore, large corporate structures, was an inevitable consequence. And with this rapidly increasing demand for higher-quality goods and increased services at lower prices came the necessity to set up new functions and new departments, presided over by trained experts.

By many it is felt that the small producer no longer has a place in the sun. To me, this belief is entirely without foundation. For even today the small producer who is a specialist in his field, who gives the entire time and thought of his organization to his particular product, is often better-equipped to meet the changing times and tide than the large producer who, of necessity, has built up a great organization and who, therefore, has not the flexibility of control of his organization or expenses that is the safety valve of the small operator.

Yet there are many industries where large investment in plant and equipment is essential. The steel industry is an example. The modern strip mill making possible the production of sheets at low cost calls for millions of dollars for a single unit. Then there is the automobile industry where only mass production has made survival possible, and the packing industry, the harvesting-machinery industry, and so on ad infinitum.

This trend toward larger units and more complex problems has driven a wedge between the chief executive and his personnel, not by choice, but through necessity. He has been compelled to become a student of merchandising, of finance, of accounting, of production, of research. He must have at least a foundation knowledge of each of the major activities of his corporation, and must be prepared, not only to discuss such problems intelligently, but to arrive at sound decisions.

With the constant increase in legislation, federal, state, and local, he must have the knowledge of a lawyer, and an understanding of the legal implication of every policy which he undertakes. The pressure of his responsibilities has drawn him from those close associations with his workmen, and often with his supervisory organization, and has created an atmosphere of aloofness which is often interpreted as lack of interest and human understanding.

In his effort to overcome these handicaps, the industrialist has sought substitutes for the personal contacts that were such a vital part of the sympathy between the workman and the manager in days gone by. First, employment managers, and later, personnel directors, were created in an endeavor to continue the old relationship. Health departments were set up as a substitute for the friendly visit at the home, or neighborly report on illness or accident. Safety committees were created, and later, in many of the most progressive companies, groups chosen by the workers and by the managers sat down together to confer on their common problems and to correct practices that were prejudicial to either group. Unfortunately, such foresighted policies were not generally adopted, and the planting of this newly discovered seed was far too thin to provide an adequate harvest.

The changes from a relatively simple industrial system to a highly complex one was well under way before the United States entered the World War. But our war involvement, with the necessity of increased output, additional plant facilities, and hurried pyramiding of personnel, speeded the process to an unfortunate degree. Haste makes waste, even though the haste is inevitable.

In the minds of many people, wars are an inevitable consequence of world changes. By some, they are believed to be a necessary element in bringing about social changes. I should indeed be venturesome if I attempted, in a short half hour, to contradict such opinions. For history has produced ample evidence that some evils of the past were so great that conflict seemed the only instrument by which they could be corrected. But the wars of olden time, like industry of the past, were simple affairs compared with the battles of the twentieth century. It is not the soldiers that bear the brunt of the wars today, but those that stay at home—the women, the children, yes, and the generations to come.

The simple economics of the past could be readjusted comparatively quickly following even a major conflict. But those of today, with their intricate operations, are so complex in their mechanism that they cannot be reconstructed for generations. Not only our economic, but our moral fibers are ripped apart. Their dislocations are so great that men and women, employers and employees, have their belief in the fundamentals of the past shattered. They seek new plans, untried remedies, hastily conceived expedients. The nineteenth-century satisfactions, discarded in the hectic postwar urge for change, are laid on the shelf and forgotten.

So management today faces a task requiring far more character, ability, and human understanding than ever before—not only by reason of the complexity of management's new problems but because of present-day psychology as well.

Ability and character are hewed out of rock. They are not formed by the soft touch of the sculptor's fingers on moistened clay. The very complexity of management's problems today,

Presented at a meeting of the Metropolitan Section, New York, N. Y., Jan. 31, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

the absolute necessity that they be solved, have forced the forward-looking executive to reanalyze his policies and his procedures, to reappraise their relative values. He has asked himself more frankly than ever before: "What exactly are my aims and my opportunities? How can they be achieved while discharging my responsibilities?" The answer is, no doubt, a most difficult one. But oh, how important it is that it be answered correctly!

I have searched diligently for that formula, and in my quest have followed a long-time custom of consulting those men who exemplify the finest qualities of business leadership. As a result, I am weaving a fabric, thread by thread, not from fiber handed to me but by a piecing together of particles of information, out of which I have assembled what I might describe as a synthetic yarn.

The aims of intelligent management, as I discover them, spring from their responsibilities. For in the process of reanalyzing present-day responsibilities they are found to cover every segment of society. We might logically say that management's first responsibility is to stockholders. For, after all, it is the stockholders who make possible the existence and continuance of the enterprise. Management's second obligation is undoubtedly to employees, for without their willing cooperation the enterprise cannot continue. And certainly management's responsibility to its customers is outstanding, for without their willingness to buy, their favorable attitude toward the quality and price of the merchandise, there would be nothing to produce. And then there are the creditors. Management has very definitely the obligation to gain the good will of suppliers, whether of materials or money. For without their good will, inventories cannot be maintained on a competitive basis. And who make up these groups to which management is responsible? Why, the public, of course—every segment of the public. And to some extent, customers, suppliers, and occasionally employees are stockholders, and each group makes up a cross section of the public. Therefore, progressive management has a definite responsibility to all society, and its aims must therefore include a recognition of social responsibility. Stated in another way:

Recognition of the rights of all, whether within or without the circle of an industrial enterprise, is management's responsibility and should be its aim.

This is the thread that must be used as the warp of this new fabric.

Before winding this warp on our loom, we must be sure that its strands are sufficiently strong to withstand the wear and tear of the shuttle. To provide this strength management must see to it that every fiber is sound. In other words, the successful executive of today must give tangible evidence to his stockholders, his employees, his customers, and his creditors that he realizes that their interests must be recognized and conserved in every policy which he establishes. Beyond this he must assure himself that these policies are in keeping with the welfare of the community within which he operates.

Not many years ago management felt that its obligations were confined within the walls of its plant. There was little realization of responsibility to society as a whole. Recognition of the changing trend of world psychology developed slowly—far too slowly for the safety of our free enterprise system. As a result, industry was misunderstood, its purposes were questioned. The misdeeds of the few were interpreted as the practices of the majority.

Only recently have executives visualized the necessity of regaining the good will of the public generally. The story of the industrial development of this country is the most marvelous tale ever told. Far too long did we delay its telling. Both those within and without the circle of an enterprise had a right to know it. And management has the duty of telling it. Sound public relations is definitely a duty of management. It should be one of the strongest strands of our warp.

During my 40 years in business I have always felt an urge to take some part in activities not directly concerned with my immediate duties. This has brought its own reward in contacts with the leading citizens in the various communities in which I have lived and worked. It has made possible deep and lasting friendships, from which I have gained a knowledge of the personal characteristics and the mental attitudes of outstanding executives. In almost every instance I have been impressed with the willingness of these men to listen open-mindedly to opinions often diametrically opposed to their own. Not only did they listen, but many times they were swayed by sound arguments.

This malleability of mind is the first thread of the weft which I am weaving into my new management fabric.

Previously, I have referred to my search for ingredients for my formula through consultation. During the last few years I have been particularly fortunate in my intimate contacts with 76 outstanding industrialists, scattered from coast to coast, who constitute the directorate of the National Association of Manufacturers. It was from my talks with these men that I picked the third thread of my fabric.

I might describe it as tolerance, or understanding.

By some, it might be described as humanitarianism. Yet it must not be thought of as charity. It is, in fact, enlightened self-interest.

I confess that it is for many industrialists a newly developed ideal. It springs from necessity—the necessity of finding a means by which the executive can regain his contact with his employees—by which he can renew his understanding of their points of view, their hopes, and disappointments. It is an attempt to remove the wedge driven between top management and their working forces.

Many of these enlightened friends of mine have already taken steps to revive this old relationship. Their method is to shift the detail of organized supervision of the manifold problems of today to other shoulders, often to specialists, and again to spend a substantial part of their time in their shop and with their organizations. It is still necessary that they have knowledge of every important phase of their business so that their policy decisions may be wise and based on facts. But they recognize that their most important duty is that of the personal relationship, the cordial and sympathetic understanding between employer and employee.

Unfortunately, recent legislation, no matter how high-minded its purpose, has made this task more and more difficult. For many provisions of this new legislation have served to create barriers between the man who works in the shop and the man who works in the office. In other words, class consciousness has been developed—a belief that the basic interests of the employer and the employee are not the same.

Many thinking people ask if we can continue to go forward as a classless society—whether the time is not approaching when the opportunity of the individual to progress from the rank of unskilled labor to that of top management may cease. I admit that there are many influences pressing in that direction. But when the unhampered opportunity of American youth to gain the full reward of his ability, his industry, his perseverance, and his integrity ceases, then surely will the death knell of free enterprise be sounded. Then will the word "finis" be stamped on our American Way of Life.

An now I reach the final thread that binds my fabric together—the quality of fundamental honesty.

Without this thread, the fabric of my formula would fall

(*Continued on page 214*)

Developments in

DOMESTIC HEATING

[A symposium of papers on various phases of the domestic-heating problem was contributed by the Fuels Division and presented at the Annual Meeting of The American Society of Mechanical Engineers, Philadelphia, Pa., Dec. 4–8, 1939. The subject papers have been condensed in the following presentation to serve as a review (I) of the developments in low-pressure heating-boiler design and construction, for hand and automatic firing, together with the present trends and future possibilities, as well as methods for rating and testing; (II) the advance of the domestic oil burner in its 20 years of intensive progress, and the present-day improvements in methods for burning low oil rates economically in combination with inexpensive heat-absorbing members; (III) the increasing use of anthracite as a domestic fuel brought about by improvements in automatic stoker firing; (IV) by-product coke as a fuel, modern processing methods, advantages in high heat value, and elimination of smoke, hand firing, and automatic stoker firing of this fuel; (V) the increasing adoption of gas by the domestic-heating market in the field of warm-air heating, and in multifamily dwellings.—EDITOR.]

I—Domestic-Heating Boilers for Automatic Firing

BY L. N. HUNTER

MANAGER OF RESEARCH, NATIONAL RADIATOR COMPANY, JOHNSTOWN, PA.

DOMESTIC-HEATING boilers are those intended for the heating of homes and small apartments as distinct from boilers for larger apartments, factories, and large buildings. These boilers usually have net load ratings of less than 1500 sq ft of steam, or in other words, are used to heat buildings having calculated heat losses of 360,000 Btu per hr or less.

The term "automatic" may apply to automatic firing of the fuel itself or automatic control of the rate of firing or both. A stoker-fired boiler may be considered as automatic but with certain types it is necessary to fill the stoker by hand. Hand-fired jobs may be considered as automatic or semiautomatic if equipped with a room thermostat controlling an electric-motor-operated damper regulator on the boiler which in turn regulates the rate of firing or combustion by regulating the supply of air for combustion.

Until recent years, the approach to domestic-boiler design has been more practical than scientific. The advent of automatic heat has made it necessary, however, to design on a more scientific basis and, to this end, many manufacturers have established or increased their laboratory facilities.

CLASSIFICATION OF BOILERS

Domestic boilers may be divided into various classifications, the two usual methods being on the basis of construction materials, and according to the fuels with which they are to be used. The two materials most commonly used in boiler construction are cast iron and steel.

Classification according to fuels may be made as follows for both cast-iron and steel boilers:

Boilers for hand firing, equipped with partial or semiautomatic control.

Boilers for oil firing.

Boilers for gas firing.

Boilers for anthracite- and bituminous-stoker firing.

Universal or all-purpose boilers designed especially for the application of more than one type of fuel.

Steel Boilers. Steel boilers for domestic purposes are made in many different designs. The boiler shell itself is usually fabricated in one-piece construction by electrically welding together steel plates of the proper specifications (1).[1] Most steel boilers are of fire-tube construction in which the hot flue gases pass through the tubes. Water-tube construction is seldom used for domestic steel heating boilers. Such parts as the doors, base, smoke hood, and grates, commonly called the plate work, are usually made of cast iron.

Cast-Iron Boilers. Cast-iron boilers are made in many patterns and invariably consist of a number of cored sections assembled together. Two types are most common, namely, round and rectangular or sectional boilers. A typical example of a round boiler is shown in Fig. 1 and of a sectional boiler in Fig. 2. Both types may be increased in size by adding additional sections but in the round boiler the sections are added vertically and the grate area and space for combustion remain the same, whereas, in sectional boilers the sections are added horizontally and the grate area and the combustion space increase with the addition of sections.

Cast-Iron Versus Steel Boilers. Years ago steel boilers and cast-iron boilers were made by different manufacturers, consequently the competition was very keen between boilers made of these two materials. Today many manufacturers make both kinds and are therefore impartial as far as material is concerned. The material has no effect upon the efficiency or operating economy of the boiler. It is possible to design as efficient a boiler with one material as with the other.

Hand-Fired Boilers, Semiautomatically Controlled. This equipment usually consists of the conventional cast-iron or steel hand-fired coal boiler, equipped with an electric motor which controls the rate of combustion in the fuel bed by operating the dampers which regulate the supply of air to the fuel, or a blower which also regulates the supply of air to the fuel bed.

[1] Numbers in parentheses refer to the Bibliography at the end of this paper.

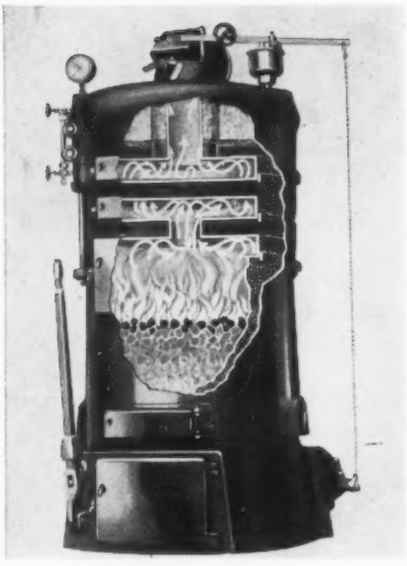

FIG. 1 ROUND CAST-IRON BOILER, HAND-FIRED

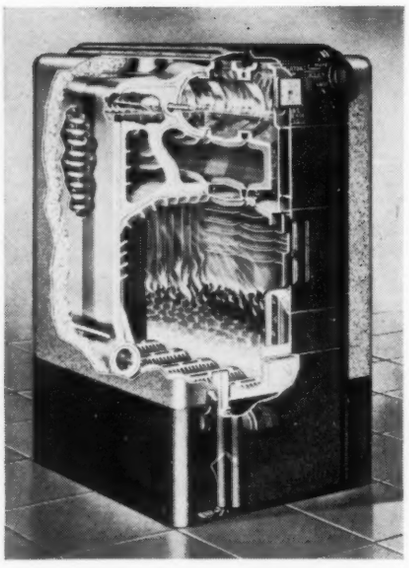

FIG. 2 UNIVERSAL TYPE CAST-IRON SECTIONAL BOILER, HAND-FIRED

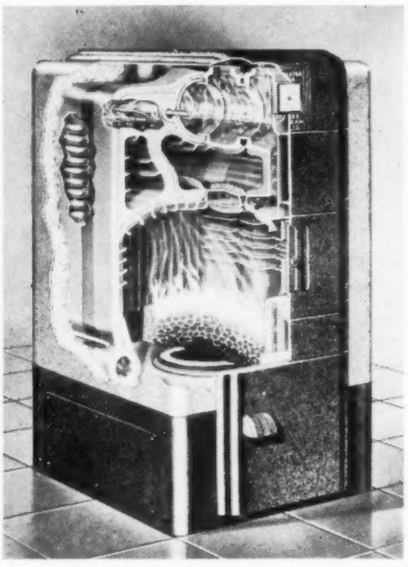

FIG. 3 UNIVERSAL TYPE CAST-IRON SECTIONAL BOILER, STOKER-FIRED

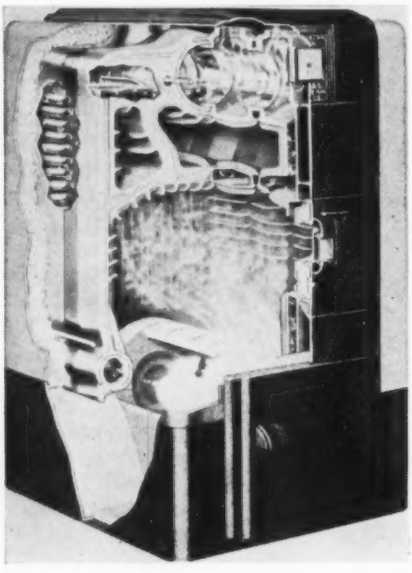

FIG. 4 UNIVERSAL TYPE CAST-IRON SECTIONAL BOILER-BURNER UNIT

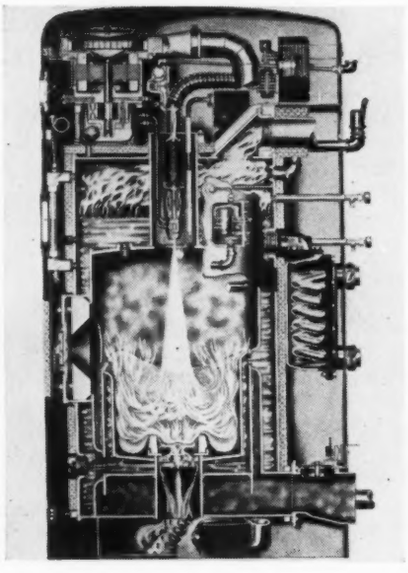

FIG. 5 OIL-FIRED STEEL BOILER-BURNER UNIT

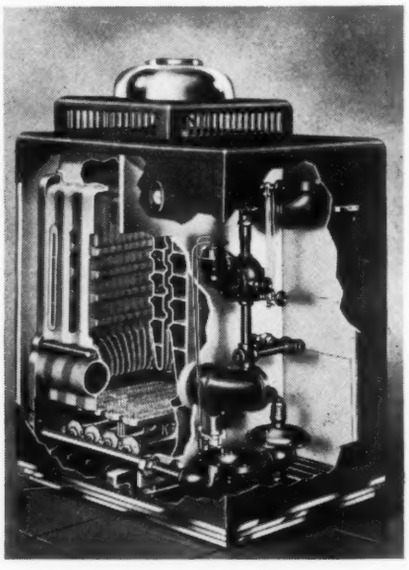

FIG. 6 GAS-FIRED CAST-IRON SECTIONAL BOILER-BURNER UNIT

In either case the apparatus is invariably connected to a room thermostat which governs its operation, depending upon the heat requirements in the building. Fig. 2 shows a typical example of a hand-fired boiler although the automatic control is not shown.

Universal or All-Purpose Boiler. The so-called universal or all-purpose boiler has become quite popular during the last year or two and a number of new designs have been placed on the market. It is designed to operate efficiently with more than one type of fuel, usually for hand, oil, gas, or stoker firing. The advantage of this type of boiler is obvious in that a home-owner can change from one type of fuel to another, if he wishes, with a minimum of difficulty and expense. This type also has applications in houses built for sale where the builder does not know what type of fuel the owner chooses to burn until the house has been sold. An example of a cast-iron universal or all-purpose boiler, arranged for different systems of firing, is shown in Figs. 2, 3, and 4.

The boiler should be designed to accommodate a built-in water heater of either the storage type or both the storage and instantaneous type. In some cases the boilers are so designed as to accommodate a number of different sizes of water heaters.

Boilers for Oil Firing. There are probably more different designs of boilers built exclusively for oil firing than for use with any other type of fuel. Two types are in common use. One is sold as a boiler only, designed for the application of any one of a number of different makes and types of oil burners. The other type is provided with burner equipment and sold as a complete unit, the burner and boiler being designed as integral

parts. Examples of boiler-burner units are shown in Figs. 4 and 5.

Boilers for Gas Firing. Almost all boilers designed exclusively for gas are of the unit type completely equipped with their own burners and controls. These boilers have assumed a uniformity of design or pattern similar to that shown in Fig. 6. The boilers are designed so they can be used for steam and hot-water heating systems, except for changing one or two controls. The same burners are used for natural, mixed, and manufactured gases, except that when mixed and manufactured gases are used, the ports on the burner are usually drilled smaller to prevent flashbacks.

Boilers which bear the seal of approval of the American Gas Association must be designed so that their construction and performance meet with the requirements of a code (2) or standards developed by that association.

Boilers for Stoker Firing. Stoker-fired boilers may be fired with either anthracite- or bituminous-coal stokers. There are few boilers on the market which can be termed exclusively "stoker-fired boilers." Most of the stoker-fired boilers are adaptations of the universal or the oil-fired types. This type includes both the boiler for use with different makes and types of stokers and one in which the boiler and stoker are designed as a unit. Most units, however, are in the former class.

As in the case of oil-fired boilers, ease of installation of the burner equipment and controls is important and built-in water heaters are quite common. One of the worst features encountered in stoker firing is the fly-ash problem and adequate provision should be made to enable removal of fly ash from the flues.

TRENDS IN DESIGN

Automatic firing on a large scale is a comparatively recent development. The continued and increasing use of oil burners, gas burners, and stokers has led to the development of special boilers for efficient operation with this equipment which was formerly used in conjunction with boilers designed exclusively for hand firing with varying results—some not very good.

Today, there is not only a trend toward special boilers for automatic firing but also toward complete units as shown in Figs. 4 and 5 in which the boiler and burner equipment are designed as integral parts and sold as such. This piece of equipment includes the boiler, burner, combustion chamber, controls, and usually a water heater. The advantage of this type of equipment is that all of the equipment is properly coordinated. The burner is of sufficient capacity and is more likely to be properly installed with the proper controls and combustion chamber than if the selection of the different equipment is left to the fitter or dealer making the installation.

Another definite trend is to embellish the boilers more than they have been in the past. Boilers are now designed to be jacketed and proper allowances are made in the design. The jackets on many boilers completely enclose controls and burner equipment. Insulation is provided between the jacket and the boiler. The finish used is usually baked enamel.

Another important trend is that toward the design of smaller boilers. This is necessitated by the fact that smaller houses are being built and many are being insulated. Both of these factors tend to decrease the required capacity of the heating system. The development of the small boiler has been held back by the lack of adequate and inexpensive burner equipment. Until recently, many burner manufacturers would not recommend firing rates less than $1\frac{1}{2}$ gal of oil per hr or thereabouts and, consequently, boilers larger than a building actually required were necessary to absorb the heat generated by the burner with a reasonable degree of efficiency. During the last year many oil burners have been announced which have capacities of 1 gal per hr or less. Consequently, small boilers with better-proportioned combustion chambers are practicable.

The heating of hot water for domestic purposes by means of the fire in the boiler has been common for many years. In the evolution of modern water-heating methods, the first step was to replace the coil-in-the-firebox type of heater with the external heater. This type was particularly adapted to automatically fired boilers. Following this, steps were taken to provide hot water throughout the year by continuous operation of the boiler, controlling the heating system so that steam or hot water would not be circulated through it. Another development in water heaters has been the built-in heater which consists of copper coils installed in the boiler section itself. These heaters are of various designs, some of which may be used with a storage tank, while others are provided with sufficient heat-exchange surface to heat the water passing through to a degree which makes a storage tank unnecessary.

SOME IMPORTANT FEATURES OF DESIGN

Steel and cast-iron boilers are invariably designed to meet the requirements of the A.S.M.E. Rules for Construction of Low-Pressure Heating Boilers. The existence of a number of individual construction codes has proved quite troublesome to boiler designers in the past but most of these have been eliminated in favor of the A.S.M.E. Code.

There is considerable difference of opinion over many features in boiler design. For example, there is no agreement on the amount of steam space, steam-releasing area, or water content that should be allowed in a boiler but they all have some effect upon its operation. If the steam space is too small, the boiler will have a tendency to prime. If the steam-releasing area is not sufficient, the steam will leave the surface of the water at a high velocity and may carry some of the water into the heating system with it. Some favor a very small water content, claiming faster pickup after the burner turns on. A normal water content is preferable if the boiler is equipped with a heater for domestic hot water and a summer-winter hookup as it gives longer operating cycles for the burner, resulting in less tendency to produce soot.

The amount of combustion space required for burning the fuel is another controversial subject. For a hand-fired boiler, it must be sufficient to provide a reasonable fuel-storage capacity so frequent firings are not necessary and also space for circulation of the flue gases to the flues. In connection with automatically fired boilers we speak of release rate which is the Btu burned or released per hour per cubic foot of combustion space or furnace volume. Figures specified for release rate may vary from 25,000 Btu per cu ft up. Actually, a number of oil-fired units on the market are operating satisfactorily on release rates well over 100,000 Btu per cu ft.

Battelle Memorial Institute recently conducted field tests on a great many stoker installations in different cities and the results (3) indicate that the amount of combustion space has comparatively little effect upon the tendency to smoke; there was a wide variation in the release rates which were used in these boilers.

The design of the passages for the circulation of water and flue gas is important because it affects the heat transfer. In steel boilers all of the water is contained in one body and is not broken up into separate sections as it is in cast-iron boilers. In cast-iron boilers, the sections are usually designed so that water passes through tubes. The circulation of water through these tubes should be rapid to promote good heat transfer but not so rapid that it acts as a fountain on leaving the water line.

It is best to arrange the tubes so as to avoid, if possible, a condition in which steam and water are circulating in opposite directions in the same tube.

The flue passes in a boiler should not be too large but should be broken up by cross tubes or heating surface in order to obtain good heat transmission. They must not be so small, however, that a reasonable accumulation of soot and fly ash will adversely affect the operation. The flue passes should not create too high a draft loss or pressure drop through the boiler.

Turbulators or baffles are frequently used in the steel tubes which form the gas passages in steel boilers. These create turbulence and increase the heat transmission. There is an increasing tendency toward the use of baffles in cast-iron boilers as well.

The amount of heating surface is not a proper indication of how much heat will be absorbed as its arrangement in the boiler has a considerable effect. It must be readily cleaned or it should not be considered as effective surface. During the last few years the use of extended heating surface on the side of the hot gases has become common.

The efficiency of a boiler is not the only criterion of satisfactory performance although it is a desirable characteristic. Poor efficiency in a boiler may be due to its design or to the method of firing or a number of other factors not depending upon the design of the boiler itself. Installation and adjustment of the burner equipment are important. Great care should be taken properly to seal the boiler against leakage of air into the combustion chamber. Air leakage tends to cut down the available draft, decreasing the CO_2 and, consequently, the efficiency.

Steel boilers are more susceptible than cast-iron boilers to corrosion of a pitting nature. Cast-iron boilers are susceptible to a different type of corrosion which, although it does not usually eat through the sections, can prove troublesome. It is difficult to prevent corrosion but it is possible to minimize its effect in the design.

RATING AND TESTING

The matter of rating boilers is a perplexing problem which has not been satisfactorily solved to date. There is no consistent and generally accepted method of determining ratings and there is no consistency in the meaning or terminology applied to the ratings selected. The proper way to express ratings is, of course, in terms of Btu output which the boiler is capable of delivering. Without discussing the various factors involved in ratings, it may be said that the boiler must be capable of delivering at the header or outlet of the boiler sufficient heat to take care of the following:

(*a*) The net load, which consists of the heat emission of the connected radiation required to heat the building together with the heat required by water heaters or other such apparatus connected to the boiler.

(*b*) The piping load, which consists of the heat emission of the piping connecting radiation and other apparatus to the boiler.

(*c*) The pickup or warming-up load, which is that required to heat the boiler and its contents and the radiation and piping to normal operating temperatures.

Boilers designed exclusively for gas firing are usually rated in accordance with the code (2), sponsored by the American Gas Association.

Steel boilers, whether for hand or automatic firing, are usually rated in accordance with the Steel Heating Boiler Institute (S.H.B.I.) Code (4).

There is no universally accepted uniform method of rating cast-iron boilers other than those designed exclusively for gas as previously mentioned. Manufacturers have rated them according to their own ideas. Oil-fired boilers have been frequently rated on the basis of the amount of heating surface they contain. The Heating, Piping, and Air Conditioning Contractors National Association has adopted its own ratings for boilers made by various manufacturers in preference to those used by the manufacturers; these are published in a Net Load Recommendations Booklet (5) issued twice a year.

The Institute of Boiler and Radiator Manufacturers, which is an association of manufacturers of cast-iron boilers and radiators, has been working on a code (6) for rating boilers, requiring that boilers be rated on the basis of test performance. This code specifies how the boilers must be tested and how they must be rated on the basis of these tests.

The methods for testing boilers for efficiency and performance which have been most commonly followed in the past are those outlined in various test codes of the American Society of Heating and Ventilating Engineers (7, 8, 9, 10, 11). For cast-iron boilers the methods outlined in the I.B.R. Code, however, may become general. None of these codes explains testing technique and there is a great need for a thorough dissertation on this subject.

CONCLUSION

Boiler manufacturers proceeded for many years making hand-fired boilers and few changes were incorporated in their design. For the last 10 or 12 years, however, the industry has been in a constant turmoil as far as product is concerned and many new boilers have appeared on the market. Newcomers have engaged in this field, including manufacturers who previously were making other products and have now added heating equipment to their lines. It is difficult to predict what will happen during the next few years. Possibly, present designs will suffice for this period, or possibly the more scientific approach to boiler design will result in additional changes and improvements.

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II—Domestic Oil Burners

BY M. A. POWERS

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THE ease with which oil and air may be united, releasing an abundant supply of heat, has been known for many years. An ample supply of oil, unfailing prevalence of air, plus considerable mechanical ingenuity brought forth the modern automatic oil burner.

It was quite natural that oil, with its inherent ease of storage, handling, and flexibility in burning, should find a ready market in the house-heating field. However, it was some time after the World War before much attention was given to the development of oil burners for domestic use.

Compared to present-day equipment, our first domestic burners were crude, costly, and troublesome. They did, however, provide comfort, convenience, and cleanliness, a combination which was otherwise practically unobtainable in the densely populated central and eastern United States.

Beginning in 1920 with an estimated total of 12,500 domestic-heating installations utilizing oil fuel in operation, sales have steadily increased. The number sold each year for the last 4 years, including 1939, will average more than 190,000. Allowing for removals and replacements, a responsible estimate made in January, 1940, placed the total number of mechanical burners operating in excess of 1,815,000. This does not include considerably more than 3,000,000 burners of lower capacity of the distillate type now so popular for small-house heating and cooking purposes.

With millions of burners in operation, fuel-oil sales are important to the oil companies. A space heater uses 600 gal per year. A conversion burner for an average house requires 1500 gal. New-equipment sales during 1939 alone will add 400,000,000 gal or approximately $26,000,000 worth of oil to the demand. This volume plus more than 4,000,000,000 gal burned in 1938 with retail value in excess of $250,000,000 meets most definitions of "big business."

Predictions have been made that fuel-oil gallonage may eventually exceed that of gasoline. During one month in 1938, the sale of fuel oil was greater than gasoline. Despite increased usage, the wholesale price for fuel oil has been downward over a period of years. The never-ending oversupply of crude oil precludes any shortage for many years to come

The retail price of fuel oil, which varies from 6 to 7 cents per gal, remains reasonably stable. Compared to gasoline, from which taxes, high cost of advertising, and expensive distribution should be deducted, fuel-oil prices are quite attractive to the oil companies.

Naturally enough this large and growing division of the oil industry is receiving the attention it deserves. Cooperative efforts have produced standardized oils suited to burner requirements. This, in turn, has much improved burner reliability through delivery of oil of unvarying quality.

The industry has been fortunate in having the cooperative support of Underwriters' Laboratories in establishing standards for the manufacture and installation of domestic oil burners. Every burner worthy of its name bears the Underwriters' label. It is interesting to note the growth in the number of separate oil-burner manufacturers listed from year to year: 2 were recorded in 1920; 30 in 1925; 130 in 1930; 230 in 1935; and in 1939, separate producers numbered 278.

In 1925 a good conversion burner installed in an existing heating plant cost about $1000. In 1929 an average conversion installation cost almost $700. In 1935 the equivalent could be had for $317, while in 1938 the cost was $271. Throughout this period, the equipment has become more reliable and economical in operating cost, at the same time being unsurpassed in its ability to provide heating comfort. Room temperatures are accurately maintained. Soot, dust, dirt, and odors are eliminated. Quietness of operation is assured. Early concern as to possible hazards has long since disappeared.

TYPES OF BURNERS AVAILABLE

Most burners are of the conversion type adapted for installation in existing boilers or furnaces. Until recent years complete oil-fired heating plants of coordinated design were unobtain-

SALES OF OIL-BURNER APPARATUS IN THE UNITED STATES

	Domestic-heating burners				Domestic distillate burners						
Year	Total	Conversion	Boiler units	Furnace units	Total	Cooking ranges	Space heaters	Water heaters	Conversion burners	Industrial burners	All types, total
1921	9000	9000	..	...	....	....	....	...	....	...	9000
1922	35300	35300	..	...	....	....	....	...	....	...	35300
1923	43000	43000	..	...	....	....	....	...	....	...	43000
1924	79700	79700	..	...	600	....	....	...	....	...	80300
1925	45200	45200	..	...	3300	....	....	...	....	...	48500
1926	77700	77700	..	...	4800	....	....	...	....	...	82500
1927	82700	82700	..	...	8700	....	....	...	....	...	91400
1928	107500	107500	..	...	40100	(a)	(a)	...	....	(a)	147600
1929	131300	131300	..	...	96200	(a)	(a)	...	....	(a)	227500
1930	126400	126400	..	...	115500	76100	39400	...	....	13600	241900
1931	104000	104000	(a)	(a)	191600	148200	43400	(a)	....	8600	295600
1932	86200	86200	(b)	(b)	274000	224400	44400	5200	....	6300	360200
1933	89300	80800	7900	600	263500	179500	76000	8000	....	9500	352800
1934	110100	100000	9300	800	180900	86500	84300	10100	....	14300	291000
1935	156700	142400	11000	3300	269800	85800	161900	22100	....	15000	426500
1936	214970	192860	14500	7610	409100	13100	213800	10700	171500	14747	624070
1937	202600	177000	14300	11300	476000	17000	275000	18000	166000	15505	678600
1938	156870	136000	11430	9440	352200	36000	210000	24200	82000	9888	509070
1939	224620	189420	18800	16400	482230	111840	238880	39600	91910	12740	719590

(a) Not available.
(b) Included in conversion-burner figure.
Data supplied by the Oil Burner Institute.

able. Even now probably not over 15 per cent of the average manufacturer's output is in complete units. A conversion burner may be seriously handicapped by the boiler or furnace in which it is installed. Marked increase in economy follows proper combination of heat-releasing and heat-absorbing elements. This fact is now receiving the attention it deserves.

Domestic oil burners fall into two broad classifications, depending upon the method of oxygen supply for combustion. Mechanical-draft burners, as the name implies, have positive means for maintaining a predetermined flow of air to the combustion zone, regardless of draft conditions. Natural-draft burners on the other hand depend upon maintenance of a draft. Burner output and operating efficiency necessarily vary with stack conditions.

Mechanical-draft burners, in one form or another, have been universally installed for heating plants burning 1 gal of oil per hr and over for medium- and large-sized houses. In fact, with one notable exception to be mentioned, such burners because of mechanical limitations usually do not operate reliably at lower oil rates.

Conventional burners now are largely sold for houses costing as little as $5000. As it becomes possible to install these burners in smaller houses, the potential market increases tremendously.

Within the last 10 years, hundreds of thousands of small natural-draft-type burners have been sold for converting coal stoves and kitchen ranges to oil. This has been done at low cost and with considerable success. Simultaneously, a modern substitute for the parlor stove was found. Known as the oil-burning space heater, it comprises a small natural-draft burner housed in an attractively finished cabinet. The last 5 years have seen a phenomenal increase in their use. In 1938, there were 370,000 units sold.

Usually, these heaters burn an average of $^1/_2$ gal of oil per hr. Consequently, they are found principally in small houses, costing up to approximately $2500. A continuous source of heat is provided, possibly even thermostatically controlled. They form a most acceptable substitute for solid-fuel heating.

Progress is being made, and considerable activity evident, in efforts to burn larger amounts of oil with natural-draft burners. These are usually incorporated in direct-fired units intended for warm-air heating systems. Such equipment has the advantage of low initial cost.

Thus oil for heating is available in most practical form for small houses up to $2500 and for large houses down to $5000. We quickly recognize that the market between, namely, for homes valued from $2500 to $5000, is tremendous. It is to this market that the oil-burner industry looks for its greatest future expansion.

The majority of mechanical-draft burners are of the high-pressure atomizing type. A typical design comprises a motor turning an impeller fan and a gear-type oil pump. Oil under high pressure is atomized by discharge from an orifice, fan air is admitted, and the mixture is ignited by an electric spark. Combustion takes place in a chamber within the heating plant and the burner is mounted outside. The normal firing rate ranges from $1^1/_4$ to 3 gal per hr, depending upon the nozzle-orifice size. An impractically small orifice is necessary for rates below 1 gal per hr, which is the desired flame size for small houses.

Next in total volume among the mechanical burners is the wall-flame type. This consists essentially of a flat hearth sealing off the boiler ashpit with a central opening through which a motor-driven, vertical shaft projects. Oil and air are distributed radially outward by centrifugal force, with combustion initiated and completed in close proximity to the boiler wall. This type is extremely quiet in operation. Combustion efficiency is unexcelled at oil rates from $^1/_2$ gal per hr upward. In view of its simplicity, low-burning ability, and the ease with which complete factory-built units may be designed, it is probable that the wall-flame burner will become increasingly important in meeting the needs of the market for small houses.

The public, having long accepted oil heating as distinctly desirable, quite naturally looks for it to form a part of new air-conditioning developments. In this field it is making rapid progress with important contributions.

III—Anthracite as a Fuel for Domestic Heating

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IN THE early days of domestic heating, the abundance of fuel minimized the importance of efficiency; and, because nearly all domestic chores were manual, there was correspondingly little demand for automatic devices.

In the years that have passed, it was inevitable that both efficiency and automatic firing should have received widespread attention. As a result, the efficiency of the heating plant is now as high as might reasonably be expected. For example, Fig. 1, based on 150 actual tests (1),[1] compares a typical well-kept domestic anthracite stoker-fired installation with the best theoretical plant that could be conceived. This illustration shows that all possible improvements within the plant itself[2] could not be expected to increase the potential efficiency more than $8^1/_2$ per cent.

The relatively high house-heating efficiencies that are obtainable, together with this low avoidable loss, combine to indicate economical heating wherever the fuel cost in terms of cents per 1,000,000 Btu is comparable with competitive fuels.

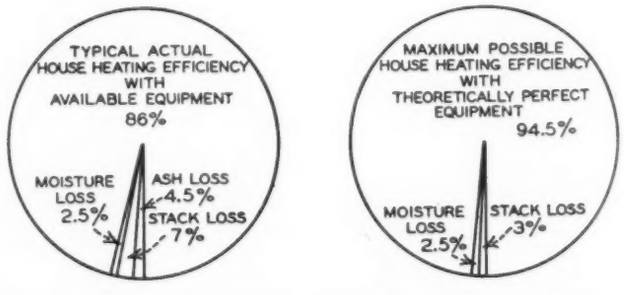

FIG. 1 COMPARISON OF TYPICAL DOMESTIC ANTHRACITE STOKER-FIRED INSTALLATIONS WITH BEST THEORETICAL PLANT

[1] Numbers in parentheses refer to the Bibliography at the end of this paper.

[2] Not to be confused with the thermal efficiency of the building which could be improved by insulation and other means, as will be discussed later.

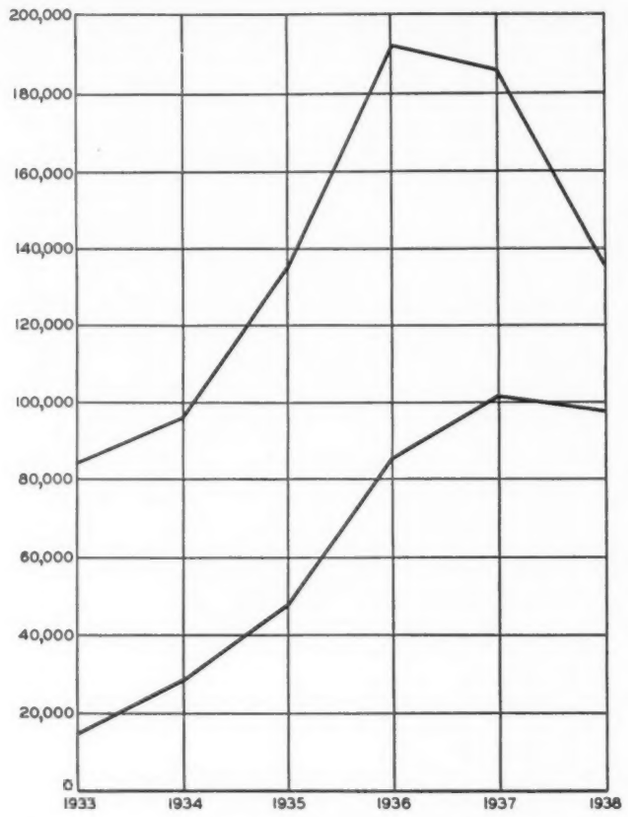

FIG. 2 COMPARATIVE ANNUAL STOKER AND OIL-BURNER SHIPMENTS

(Figures cover all types and sizes shipped in the United States, as reported to the U. S. Department of Commerce.)

With anthracite, this is fortunately the case where freight rates are not sufficiently large to change the basic fuel cost.

The second step, that of supplying economical heat automatically, is also answered in the form of the relatively new automatic anthracite stoker. Developed to full maturity only during the last few years, these devices are now available through a large number of reputable manufacturers in either the original hopper-feed type or in designs which remove coal directly from the bin without attention of any kind. Ash removal is available in two forms, either designed mechanically to place the ash in cans for convenient periodical removal, or in large pits requiring but infrequent attention.

In the last 5 years, automatic stokers have had a wide acceptance, as evidenced by Fig. 2 which shows that sales have increased from 15,000 to 96,000 in that period (2). It is also remarkable that there was a high degree of stability during years such as 1938, when almost every other industry showed marked decreases.

With this background of acceptance, economy, and dependability of anthracite equipment, the attention of engineers in this field is being directed toward further improvement in domestic-heating comfort.

The present lack of emphasis upon air-tight windows, doors, and walls is, as a result of the unnecessary air changes, decidedly heating by sheer force rather than by ingenuity. The lack of insulation in a vast majority of houses, in spite of proved economies up to 45 per cent (3), is not only heating by mass but is resulting in less satisfactory conditions for the entire 12 months than might otherwise be obtained.

Fortunately, these points are entirely familiar to the heating profession and will undoubtedly be rectified as a result. There is a point, however, of even greater importance which has not as yet received the serious attention which it deserves and that is: "Just what constitutes a comfortable house?"

Until recently, the uniform answer would have been that a house was comfortable in which the air temperature throughout was maintained in the neighborhood of 70 F. Today, there is evidence which leads us to wonder whether or not this is the correct answer. We are more conscious than ever before of the importance of radiant heat to our daily comfort. With the major questions of heating solved, advanced study of the problem is receiving an increased share of attention.

POSSIBILITIES IN PANEL HEATING

For example, in Ardmore, Pa., Frank Lloyd Wright, the world-famous architect, has carried panel heating into the living room of a three-story house (4). Steam, generated through the medium of an automatic anthracite stoker, is circulated through 175 ft of welded pipe laid in loops on a 6-in. bed of gravel and imbedded directly in the concrete floor of the living room, Fig. 3. It is claimed that the resultant radiant heat will provide an equal sensation of comfort at all points and will give the highest temperature at ankle level where it is most needed. All of the heat needed for the rest of the house rises from this floor, its circulation being controlled by opening transoms and ventilators in the upper stories. All radiators and risers are, of course, eliminated in this unusual idea of a house literally resting on a steam-heated concrete mat.

Regardless of the ultimate acceptance of this particular version of panel heating, it is most certainly a forerunner in an entirely new line of thought concerning the essentials of heat distribution. However, in view of the years which must elapse before such innovations can be universally adopted, it is fitting to pause to consider the principles which are involved and to determine whether they might not be applied to existing warm-air, steam, or water systems, in order to provide a materially increased degree of comfort with conventional equipment.

APPLYING PRINCIPLES OF PANEL HEATING TO EXISTING INSTALLATIONS

We find, for example, that the only essential difference between panel heating and our present type of radiation is that the former provides relatively large surfaces from which heat may be radiated or, speaking more literally, which will prevent our loss of body heat through radiation. In view of the fact that every room has six full-sized potential panels in the form of its walls, floor, and ceiling, it seems obvious to ask whether comfort and uniformity of heating could not be increased through maintaining them at a higher temperature than at present; thus, in effect, using them indirectly as a panel form of heat. In other words, if by supplying continuous heat throughout the days and nights of an entire winter, we would be more careful to maintain our wall temperatures at a higher and more constant point, it seems rather obvious that an increase in our comfort factor would follow.

The potential importance of this component of heat distribution was very strikingly demonstrated in a comprehensive study of the heating of small houses which the Tennessee Valley Authority has recently completed (3). In a house having a normal hourly loss of only 40,000 Btu at design temperature, it was found that with an outside temperature of 49 F, 138,500 Btu were required to satisfy the thermal capacity of the building. Thus, in addition to the amount of heat required for bringing the air up to the desired temperature, the equivalent of the full heating capacity of the plant for 3 hours must be added before heating equilibrium can be reached.

The report (3) commented that body-heat loss by radiation,

FIG. 3 HEATING COILS IN FLOOR, FRANK LLOYD WRIGHT HOUSE, ARDMORE, PA.
(At the extreme right is a finished cement floor covering the pipes; whereas, in the foreground the two groups of pipes laid in crushed stone will likewise be covered with concrete. These pipes are the sole source of heat supply.)

amounting to at least 46 per cent, is controlled by an average of the inside temperatures of the room boundaries which, in turn, necessitates adequate wall temperatures before comfort can be expected. Thus, with any type of intermittent heating, it is obvious that the almost inevitable delay in heating the walls will have a serious effect upon comfort for hours after even a minor temperature depression. This fact points definitely to the desirability of using a type of heating system and a fuel that is:

(*a*) Sufficiently inexpensive to permit its 24-hour operation at a rate which is proportionate to the outdoor temperature without depressions, artificial or otherwise, of indoor temperature conditions.

(*b*) The use of a system and fuel which may be controlled with sufficient flexibility to follow the normal outdoor temperature changes.

Anthracite has these characteristics. It is sufficiently economical for continuous use at a uniform 24-hour indoor temperature. In fact, even estimates made in the interest of equipment designed to depress night temperatures have failed to show that it requires more than 10 per cent additional heat to operate the system at a continuous temperature throughout the night. In the average 10-room house, even such an extreme condition would amount to only $10 a year, which in itself would not be expensive in return for greatly increased comfort.

The mere placement of a certain number of Btu in a room in a given period of time is not an indication of comfort, because unless continuous circulation is maintained throughout the entire heated area, almost immediate stratification will obviously occur.

In recent tests sponsored by Anthracite Industries Laboratory, calibrated thermometers were placed throughout the entire living quarters of an eight-room house and were used to measure the differential in temperature which resulted from localized circulation (5). Table 1 shows that of three types of automatic heating, the anthracite stoker, evidently by reason of its more nearly continuous output of heat, allowed only 1.2 F differential between the average temperatures of the two floors as compared with 3.7 F for each of two other fuels.

TABLE 1 AVERAGE TEMPERATURES WITH VARIOUS FUELS

	Anthracite,[a] F	Second fuel, F	Third fuel, F
First-floor temperature, living room	74.5	72.9	72.4
Second-floor temperature, upstairs hall	73.3	69.2	68.7
Difference	1.2	3.7	3.7

[a] Average for buckwheat and rice, both stoker-fired.

As a further illustration of the ability of anthracite stokers to provide uniform heating conditions, the difference between the temperatures 3 in. and 72 in. above the living-room floor averaged only 1.5 F during prolonged tests with two separate sizes of coal. This minimization of the condition, popularly known as "cold 70," is widely recognized as desirable in all types of heating.

The various factors which have been discussed as being requisites to correct heating are separately and individually the goal of practically every heating engineer. It would be a gross misstatement to claim that no fuel other than anthracite could, under any circumstances, fulfill a major part of such requirements. The claim of anthracite is, therefore, not one of exclusive command of heating comfort but is rather an emphasis upon the ease and simplicity with which such comfort can be obtained.

In conclusion, a tremendously important factor at a time like this is the dependability of supply. Anthracite always was and probably always will be, primarily, a domestic fuel. It is thus extremely unlikely that it could, under any conceivable emergencies, be diverted from its major job of providing dependable comfort in the several millions of homes where it is used.

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IV—Domestic Heating With Coke

BY CHARLES C. RUSSELL

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WHEN by-product coke actively entered the field of domestic heating somewhat more than 20 years ago, about 1,000,000 tons per year were consumed in the United States. Since that time, the total annual consumption has reached more than 10,000,000 tons. The growth of domestic-coke consumption must largely be attributed to the recognition of the desirable qualities of coke by the fuel-consuming public. However, no commodity, no matter how desirable, can long expect to exist unless the economics of both its production and consumption are sound. Coke is a premium fuel and, as such, supplies an economic need. Coke entered the domestic-fuel market when that market already had access to an ample supply of fuel and today the situation has not changed.

Coke is a clean, smokeless fuel, having high heat value and low ash content. Coke is produced 365 days in the year, assuring a constant and uninterrupted supply. Because coke is a manufactured fuel, the qualities required by the local peculiarities of each market can be supplied, thus assuring against an inferior product.

While by-product coking first made its appearance in the 1890's, its period of rapid growth began about 1908, as an adjunct to the steel industry. The history of the expansion of the by-product coke industry and technical developments in the manufacturing processes are well known to this Society. The present discussion will, therefore, be devoted to a consideration of the qualities of by-product coke as a domestic fuel, and equipment and methods both for its economical as well as efficient use.

REQUISITES OF A DOMESTIC COKE

The amount of ash in coal, the temperature at which the ash fuses, and the sulphur content of the coal are three of the most important chemical characteristics to be considered in the selection of coal for domestic coke. The volatile-matter content is also important but it is bound up with the coking characteristics and need not be further emphasized. All of the ash in the coal appears in the coke and the ash-fusion temperature is not affected by the coking process. Since the coal loses from 25 to 35 per cent of its weight during coking, the percentage of ash in the coke is higher than the coal from which it is made in proportion to the loss in weight of the coal. It is therefore desirable to select low-ash coals with high ash-fusion temperature.

The chief characteristics of fuel which the householder seeks are heating qualities, cleanliness, and convenience. These characteristics have, however, broad implications. Coke is clean in appearance, in sizing, in delivery, and in use. The care which is given to sizing both in the original separation, as well as to the rescreening to remove the fines before delivery, assures the customer of a clean fuel. Dustproofing has practically eliminated the dust attendant upon the dropping of the coke into the fuel bin and maintains the dustlessness throughout the period before use.

Coke is also a smokeless fuel. No soot is produced to pollute the atmosphere or to reduce the draft by accumulation in the furnace passages, flue, or chimney. The use of coke precludes the possibility of atmospheric pollution as well as the loss of fuel value in the unburned products.

Unlike bituminous coal, coke requires no attention between firing periods. Bituminous coal fuses together due to coking and blocks off large areas of the fuel bed from access to air. This requires that the fuel bed be broken up some time after firing. After coke is fired, no further attention is needed until the fuel has been consumed. Coke does not fuse together, but maintains an open fuel bed which gives ready access to the air in all parts, thus producing a uniform fire. Convenience in use is one of the major attributes of coke.

Another convenience of coke is the rapidity with which it responds to changes in draft. This factor is due in part to the open fuel bed. Sudden demands by the house for additional heat are promptly supplied because all parts of the fuel bed have access to the air entering when the drafts are opened. Among all of the solid fuels, coke has been found to react most rapidly and yet is subject to close regulation.

Coke is a thermally efficient fuel because it is chiefly carbon; consequently, only a small combustion space is required over the fuel bed for the combustion of evolved gases. Maximum use of the heat-absorbing surfaces of the furnace is available for the absorption of the heat in the flue gases with resulting low heat loss up the stack. The loss of heat in the dry flue gases plus the loss of heat due to unburned carbon in the ashes are the two possible sources of heat loss in the combustion of coke. The remainder of the heat in the coke is useful.

SERVICE TO CUSTOMERS

Domestic-coke producers have pioneered in supplying direct customer service. This service has for its purpose not only the demonstration of proper firing methods, but also the cooperation with the customer in furnace choice, maintenance and repair, selection of proper firing tools, and rearrangement and redesign of the fuel bin for better convenience. Customer service has also demonstrated that with a clean solid fuel such as modern coke, the dirty, dark, unsightly basement need no longer be tolerated. Plans for the transforming of the basement from an old-fashioned furnace room into a clean and pleasant recreation room are willingly supplied.

Coke needs no special firing method except that the furnace should be filled full of coke at each firing period. This procedure prolongs the time between firings. Because good coke has low ash content, little grate shaking is necessary. When the fire is burned down, a little poking with a properly designed poker is recommended, instead of shaking, to bring down the ashes. A specially designed poker is available at small cost, which has a gentle curve from handle to point, making it possible to reach every part of the fuel bed.

Coke is a light fuel and a large volume can be conveniently handled even by the housewife without excessive weight. With a shovel properly designed and constructed of wear-resistant metal, the work of filling the furnace adequately is reduced to a minimum.

High-quality domestic coke contains only a small amount of ash. Small ash receptacles that will hold the ashes produced for a whole week are consequently possible. The coke company supplies these to customers at a low cost.

The installation of an ashpit spray, which moistens the ashes with a fine water spray, lays the dust during the removal of the ash from the ashpit. This is just as important as the dustproofing of fuel before delivery.

Fuel bins should be located near the furnace and arranged for convenient furnace firing. Sloping bottoms can be installed so

that actual entrance into the bin is unnecessary when the fuel supply is low. This not only eliminates extra steps but also avoids the tracking of dirt out of the bin onto the cellar floor. A small steel plate laid in the cement at the entrance to the bin makes shoveling easier. An outlet box constructed at the bin opening may also be installed to prevent the coke from rolling out onto the cellar floor.

Delivery of coke to the home has become a specialized procedure. Large fleets of trucks of special design and of fine appearance make prompt service possible. Drivers and helpers are selected for their ability and courtesy and they wear clean distinctive uniforms. Auxiliary equipment for conveying the coke from the truck to the bin have all been carefully designed and selected to provide the least annoyance to the customer.

With the foregoing improvements available to the coke customer, he is able to visualize the modernization of his basement by the installation of a recreation room. New houses are being constructed with such rooms included and they are being installed in old homes. The installation of the recreation room in the basement is just as possible for those who use hand-fired coke as for those who have some other form of house heating.

AUTOMATIC CONTROL WITH COKE AS A FUEL

Automatic heating of houses continues with increasing interest. Coke producers are demonstrating to their customers that they may obtain any degree of automatic control according to the investment they are willing to make. The installation of a thermostat to operate the dampers, maintains a uniform fire and eliminates many trips to the basement to adjust dampers. Thermostatic control of the fire prevents wide variations and thus substantially improves customer satisfaction. High-grade thermostats are being offered to coke customers at an installed cost of approximately $25 or less. No other single piece of equipment for control of house heating offers so much convenience and eliminates so many steps for the housewife for so small an investment. Under normal conditions, the average coke-burning furnace can be filled in the morning and not touched again until evening. Many furnaces require attention only once in 24 hours. The thermostat is the first step in automatic heating.

There are stokers on the market for firing coke into the furnace which can be filled at the coke bin and wheeled into position at the furnace door. As the fuel bed sinks in the firepot, a level control starts the stoker and refills the furnace. This type of stoker is in effect an enlargement of the fuel capacity of the furnace. The time between furnace fillings may thus be lengthened to once a day or longer depending upon the demand for heat in the house.

Completely automatic coke stokers which will take coke from the bin and put it into the firebox, shake the grates, and remove ashes from the ashpit into ash receptacles are available for use with coke. These stokers are more expensive than the unit which simply feeds coke into the furnace but they are as completely automatic as any other form of equipment for house heating. These stokers have the advantage in maintaining a full fuel bed and avoiding the fluctuations in comfort which occur with intermittent furnace heating. No manual labor is involved in the use of these stokers and, beyond setting of the thermostat to obtain the required temperature in the home, little or no attention is required.

Domestic coke as a modern house-heating fuel owes its development and acceptance in the fuel market to engineering achievement. Unlike other solid fuels, coke is a manufactured product and its characteristics can be adjusted to the changes which occur with advances in the use of fuel. Coke finds its place in the fuel market in any situation from hand firing to completely automatic operation.

V—Gas Heating

BY C. GEORGE SEGELER

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COMFORT heating by gas has become a market of major importance to all branches of the gas industry within the last 10 years. Long popular wherever natural gas was available, it did not become a factor in the manufactured-gas industry until 1915. At that time, no one believed it would ever be more than a luxury for people of large income. Comfort heating by gas has changed the viewpoint of the industry itself in both manufactured- and natural-gas areas.

The gas industry looks upon the heating market as one of four jobs which it must accomplish successfully in order to progress. Therefore, it regards gas heating not as an isolated sales and engineering factor but as part of a larger program. Gas in the new homes of the United States serves as a fuel for cooking, refrigeration, water heating, and house heating. In the first two of these fields, the gas industry is primarily faced with electric competition and in the other two, heating and water heating, the competition arises from solid and liquid fuels. Experience has shown that its greatest opportunity to progress depends upon its ability to enter the new-home market on all four fronts.

To what extent the industry has been successful can be illustrated by reference to the results of new-home building for the year 1938.

Federal building records show that 150,000 one- and two-family houses were built in urban centers during 1938. A survey was undertaken in February, 1939, to see what fuels were going into these new houses. The results of this survey indicate that of all new houses built, 57.6 per cent installed gas heating, or a total of 86,400 houses; 75.1 per cent installed gas water heating; 88 per cent installed gas for cooking; and 12 per cent installed gas for refrigeration. The significance of these facts lies in the trend to gas heating shown by the choice to use gas in more than half of the new homes.

The expansion of gas-heating sales might be dismissed as a mere statistical phenomenon, but it has an interesting engineering side as well. In 1929, the average customer using manufactured gas burned 436,000 cu ft per yr, whereas the average now is 246,000 cu ft per yr. This would indicate that the trend of gas heating has been toward the smaller home and the lower-income classes. Fig. 1 shows the year-by-year decline in the average gas used per house-heating customer and the increase in total gas sold for heating expressed as a percentage of 1929 figures. The increasing acceptance of gas heating was accelerated by a steady reduction in the price of gas for this purpose. In the manufactured-gas side of the industry, this reduction has amounted to more than 25 per cent in the last 10 years. Fig. 1

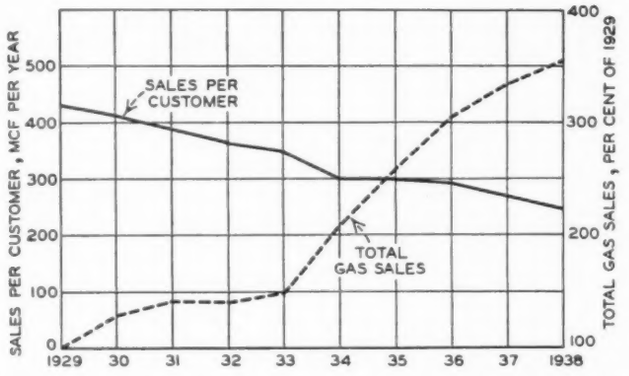

FIG. 1 YEARLY DECLINE IN AVERAGE AMOUNT OF GAS USED PER HOUSE-HEATING CUSTOMER AND INCREASE IN TOTAL GAS SOLD FOR HEATING

also shows the steady rise in the total of gas sales. The data are expressed as a percentage of the 1929 sales. The increase in the 10-yr period just finished was more than 350 per cent. The latest six months' figures in 1939 show an increase of 25 per cent over 1938, indicating that the swing to gas continues to accelerate.

ENGINEERING ASPECT OF GAS HEATING

Gas heat is surprisingly versatile and fits practically every heating problem because of the wide variety of types, sizes, and capacities of the available equipment. This point deserves emphasis since the flexibility of gas permits its use in other than conventional central-heating units. Table 1 shows the 15 principal classifications of gas-heating equipment.

TABLE 1 GAS-HEATING METHODS

Central-heating and air-conditioning appliances

1 Gas-designed boilers (steam, gravity, and accelerated hot water and vacuum vapor)
2 Gas-designed warm-air furnaces (gravity and forced warm-air types)
3 Conversion burners (boilers, warm-air furnaces)
4 Pipeless furnaces
5 Split systems
6 Humidifiers
7 Dehumidifiers for summer use

Individual heaters

8 Floor furnaces
9 Circulators (gravity and fan types)
10 Radiant heaters
11 Wall heaters
12 Garage heaters
13 Gas-steam radiators
14 Warm-air radiators
15 Unit heaters

In the East, the central-heating system has usually been installed to the exclusion of individual heaters except as auxiliary heat sources, but in the West and South the individual heater occupies an important if not dominant position. Recently, experimental installations of individual heaters in Connecticut and North Carolina have shown that they are very well adapted for heating cold-water flats, bungalows, and similar premises that are rented by thousands in the lower-income bracket. The direct heaters use from 20 to 30 per cent less gas than central systems, making them attractive when economy is a paramount issue, recognizing that uniformity, speed of heating, and the other advantages of central heating are sacrificed to a certain extent.

Gravity warm-air furnaces appear to be on the way out and are being replaced by the winter air conditioners which provide easier installation and much better heat distribution. Winter air conditioning includes controlled heating, humidification, and filtration.

Apart from the popularity of the winter air conditioners and their adaptability to the needs of the homes of tomorrow, they possess an engineering advantage over steam or hot-water heat. Contrasted with these methods, the forced winter air conditioner uses slightly less gas to heat a given house, a fact which the gas industry itself is only slowly beginning to recognize. As this becomes more generally confirmed and accepted, it may lead to an acceleration of the trend to warm-air heat. The explanation of the reason for the smaller gas consumption appears to be found in the substantially lower heat storage of the warm-air system. This makes stand-by losses smaller and thus improves the over-all economy.

In 1938, the Metropolitan Gas Heating and Air-Conditioning Council, representing the metropolitan companies around New York, assigned a committee to the job of formulating a guide of proper installation methods for winter air-conditioning equipment. This guide[1] was published in May, 1939, copies being sent to thousands of builders, sheet-metal workers, contractors, and to all gas companies. The effects of this move have already been noted. Several field trips have shown that the guide is having its desired influence in showing sheet-metal workers and contractors how to put warm-air heating systems into new houses in a manner which will assure uniformity of heating, quick response to temperature changes, and economy of operation.

From the point of view of the homeowner, there are collateral advantages to the forced winter air-conditioning system of heating apart from dust removal by filtration, humidity control, and regulation of air movement which are well known to every engineer. Less well recognized may be such facts as the increase in combined central-heating boilers and instantaneous water-heating systems. These are being sold with the thought in mind that the domestic-hot-water supplies are being furnished free or nearly so. Experiments, performed in 1935 by Professor Wilkes at the Massachusetts Institute of Technology and substantiated by a series of field tests on homes having combination gas boilers with submerged water heaters, conclusively show that the fuel consumption of such methods of heating water is very much higher per gallon of hot water

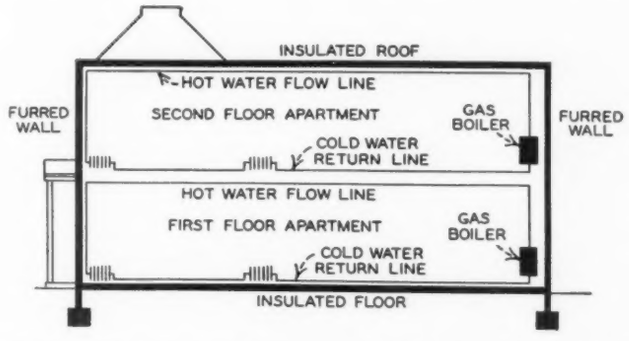

FIG. 2 CROSS SECTION OF WASHINGTON FLAT, SHOWING ARRANGEMENT OF GAS-HEATING UNITS

than methods of heating water directly. In the case of forced warm-air heating, there is, at present, no combination heating and domestic-water-heating appliance. A high standard of comfort coupled with a low cost would dictate the use of separate appliances.

[1] "Gasco Installation Guide," available from the American Gas Association, New York, N. Y.

GAS HEATING APARTMENTS INDIVIDUALLY

It should not be inferred from these remarks that there is no place for radiator heat because there are many situations in which it is decidedly an advantage to use it. For example, there is a new trend to individual gas heating of apartments, and for these, the space considerations as well as cost make the use of gas boilers most appropriate. Of course, gas-heated apartments using individual space-heating equipment are an old story throughout the Southwest and West, but in the apartment houses of the East, the first real progress was made by the Washington Gas Light Company.

Fig. 2 is a diagrammatic sketch of the cross section of a typical new-type Washington flat. For those who are interested in cost of operation, the author can report from the study of a group of new flats housing 110 families that the heating bills averaged $43 per season.

In Boston, the individual heating of 151 apartments has been installed in a 6-story building using winter air-conditioning equipment built into utility rooms. A single common flue serves each tier of apartments.

In Pennsylvania, New Jersey, and elsewhere, garden-type apartments are springing up with a rapid increase in the self-heating rather than central-heating arrangements for the apartments. Tenants like to control their own heating.

Perhaps some readers are not familiar with the program undertaken by the American Gas Association to test and certify appliances. Briefly, the industry organized a testing laboratory in 1925, and today, almost all gas-heating equipment bears the seal of approval of the association indicating compliance with national standards sponsored by the gas industry under the American Standards Association. These standards are periodically revised by a committee which includes representation of the National Bureau of Standards, United States Bureau of Mines, United States Public Health Service, United States Bureau of Home Economics, National Safety Council, American Home Economics Association, Master Plumbers' Association, Heating and Piping Contractors National Association, American Institute of Architects, Associated Factory Mutual Fire Insurance Companies, the Canadian Gas Association, as well as gas-company and manufacturer members of the American Gas Association.

Approved gas-heating appliances must carry a name plate on which the proper Btu input and the rated Btu output are clearly marked. It is physically an easy matter for the installer to adjust a gas unit so as to operate within the allowable 5 per cent of the rated input. This is entirely independent of such factors as firing period, available draft, size of unit, and kind of gas.

Estimating probable gas consumption can be made with excellent correlation with actual use because of the uniform operating conditions. To illustrate this point, it may be interesting to compare prediction with an actual result to show how closely these are now correlated. Table 2 shows the basis of predicting gas consumption. These data are in general use throughout the industry.

TABLE 2 INPUT BTU REQUIRED PER DEGREE-DAY PER 1000 BTU OF HOURLY HEAT LOSS AT 0 F AND 70 F

Type of system	Size or capacity range of installation, sq ft	Btu required per deg-day
Hot-water systems.....	Up to 500	471
	500–1200	450
	Over 1200	428
Steam-heating systems....	Up to 300	505
	300 to 700	480
	Over 700	459
Warm-air systems.....	Indirect or gravity	428
	Fan-powered	409

NOTES: (*a*) Data refer to gas-designed equipment. Conversion burners are assumed to be less efficient; (*b*) modification of data is necessary when design is on other temperatures; (*c*) data apply between 3000 and 6500-deg-day levels. Below, add 10 per cent to result; above, deduct 10 per cent.

A survey of 600 steam-heating installations, average size 342 sq ft, was made at the close of the 1939 heating season by the Public Service Electric and Gas Company of New Jersey. These houses used a total of 11.5×10^{10} Btu of gas. To check the actual metered result by Table 2, proceed as follows:

$$600 \times 342 \times 5300 \times \frac{480}{4.17} = 12.5 \times 10^{10} \text{ Btu}$$

where 4.17 sq ft of steam radiation is the theoretical equivalent of 1000 Btu hourly heat loss.

This result is 8.7 per cent higher than the actual metered gas, but the estimating method should be a trifle high in order to allow a little leeway and to prevent unfavorable customer reaction which would be anticipated if the estimates were lower than the actual consumption.

The accuracy with which gas-consumption figures can be predicted is not a matter of mere academic interest. The fact that such a close correlation exists makes it possible to evaluate a number of important engineering factors. By using the results from a large group of houses, it is possible to study the effect of size of the building on heating-plant efficiency, the effect of the type of heating systems, and even to approximate the merits of various forms of house-insulating materials. The personal equation is not completely eliminated in a gas-heated home but differences are ironed out by considering a large number of cases.

The rapid progress made in gas heating arouses interest as to its future. Engineering developments can be expected to keep pace with the demands of the times. The development of chimneyless houses with flue gases discharging into the sewer or through a small outlet pipe, the construction of a combination water heater and winter air conditioner, and the further refinement of automatic operating features can naturally be anticipated in the immediate future.

Aims and Responsibilities of Management Today

(*Continued from page 202*)

apart. For honesty is the bulwark of successful leadership. I don't mean casual integrity, the simple speaking of the truth. I have in mind that type of sturdy right-doing and right-thinking that requires courage, perseverance, complete frankness. It is the kind of honesty that begets immediate confidence. It is the basic structure on which true personality is built.

So, companions on the path of eager searching, I offer as my prescription for the "Aims and Responsibilities of Management Today"—

Recognition of the rights of all, whether within or without the circle of our activity.

Malleability of mind.

Tolerance or human understanding.

Fundamental honesty.

I realize that the ingredients are few, that the mixture might be sweetened. Yet I maintain that management which embodies these elements in their pure form can render an honorable accounting of itself, even under the rigid microscope of the world today.

INDUSTRIAL MARKETING

Abstracts of Three Papers Dealing With the Relationship of Marketing to Mechanical Engineering and Its Applications Today

[Present-day improvements in business conditions have opened up a need for evaluating the part of mechanical engineering in the general economic trend. One of the phases of this trend is the marketing movement and its dependence upon engineers for modernization of designs, improvements in mechanisms, and a coordination of production to sales. Better to acquaint mechanical engineers with the subject the Management Division sponsored an industrial-marketing session at the 1939 Annual Meeting, Philadelphia, Pa., Dec. 4–8, at which the three papers abstracted in this issue were read and discussed.—EDITOR.]

The Marketing Movement in Mechanical Engineering

BY JOHN R. BANGS, JR.

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A TREND of paramount importance to engineers is noted by Dr. Karl T. Compton, member A.S.M.E. and president of the Massachusetts Institute of Technology, when he says, "One hundred years ago the average person had about 52 wants of which 16 were regarded as necessities. Today the wants number 484, on the average of which 94 are looked upon as necessities." This statement seems to imply that engineers can satisfy these many wants through the effective application of the principles of industrial marketing.

It is well known that the engineer has for years been trained primarily in the physical sciences and that much of his success has been due to his ability to apply these sciences to the design and development of technical devices in industrial enterprises. Curiously enough, this same training has given him an entree to the managerial side of such enterprises. According to various surveys, three fifths of all engineers who live a normal life span spend over one half of their working lives in administrative work of a technical or general nature.

One is led to wonder whether the same training can possibly prepare the engineer to cope with the problems of today and tomorrow. In positions of administrative responsibility, his view must encompass all the phases of an enterprise, namely, production, finance, accounting, research, human relations, and, perhaps most important of all, marketing. In other words, he must concern himself with the integrated whole, recognizing the full significance of customer research in the field, as well as technical research in the laboratory.

For example, in recent years a very marked trend was developed toward a constant study of the product. Such studies reveal that utility and purpose are paramount. Couple these with good appearance, and sales are stimulated beyond a reasonable doubt because appearance is an important factor today.

Not many years ago any attempt to improve the appearance of a product resulted in mere ornamentation, without any effort being made to improve design, utility, or purpose. Today, however, artists and engineers are combining their efforts not only to give the public a better-looking article but also one that is basically lower in cost and much more useful.

DEFINITION OF INDUSTRIAL DESIGN

This movement, actuated by the necessities of the market and thrown into bold relief during depression years, has given rise to the comparatively new profession of industrial design. Industrial design attempts to tie together the research of the technical engineer in the laboratory and the market research in the field. It may be defined as "the art of giving a properly engineered product a striking and pleasing appearance." Hence, it may be concluded that design, utility, and purpose all point to the fact that modern selling begins in the research laboratories, in the engineering departments, and on factory floors where the engineer's influence is paramount.

In view of these facts, it appears to the author that the engineering colleges charged with the training of the engineer, and the engineering societies, such as the A.S.M.E., that guide his professional development, should sponsor curricula and programs that will aid in the development of this broader viewpoint. That such sponsorship is developing is most encouraging. An editorial which appeared in the May, 1936, issue of the magazine, *Industrial Marketing*, begins by saying that Gerard Swope, recently retired president of the General Electric Company, had suggested that most engineering courses were too narrow. It goes on to develop the idea that one way to broaden them is to include instruction in the broad principles of marketing, especially industrial marketing, in engineering schools. In conclusion it reads:

> Here is an avenue for greater usefulness for the engineering school. We realize that most courses are already crowded and that there is a constant demand for the addition of new studies; but we believe that a survey of the field among manufacturers and among graduates will demonstrate the fact that a reasonably thorough course in industrial marketing would be a valuable addition to the curricula of most engineering schools.

But there is much work to be done! How many engineers recognize the full importance of marketing in the economic order today? How many recognize that every manufacturer must manufacture two things—the product he would sell and the order that will bring about this sale? Nearly all engineers recognize the fact that lower production costs have been achieved through intelligent design, proper organization, greater output, and the use of modern production tools. Are they equally sensitive, however, to the possibilities of lower sales costs through the intelligent choice of markets, a strong sales organization, and the proper selection and use of modern selling tools?

INDUSTRIAL MARKETING IS ENGINEERING

The implication on the part of some uninformed persons that industrial marketing—the sale of industrial goods—is not engineering is most unfortunate. A sales engineer is of necessity an engineer of the highest type. A. R. Stevenson, Jr., of the General Electric Company, says, "The apparatus salesman is a consulting engineer in design."

The training of men for marketing should not be left to chance; in other words, the engineering colleges and the engineering profession must become more marketing-conscious. Engineering schools, which pioneered the teaching of industrial engineering some 25 or 30 years ago, should today give increas-

ing emphasis to the teaching of industrial marketing. Engineering societies, which glorified the work of Taylor, Gantt, and Gilbreth in production two decades ago, should realize the ever-increasing importance of these principles now that they are finding wide application in the field of marketing.

The engineer of tomorrow may with the joint help of these two bodies become an engineer in every sense of the word; he should be able to "engineer through to the end" so that the ultimate consumer may receive the full benefits of his efforts.

Gearing Engineering to Sales

BY FREDERICK B. HEITKAMP

AMERICAN TYPE FOUNDERS SALES CORP., ELIZABETH, N. J.

BOTH the engineering and sales departments are working for certain common objectives, namely, creating a profit for the company on the product that it designs, manufactures, and sells; improving the position of the organization in the industry; and making the future of the company more secure. In other words, when talking about "gearing engineering to sales," the fact must not be overlooked that there must be a satisfactory smooth-running gearing of all departments, accounting, purchasing, production, or any other of the associated departments which make up the modern industrial organization. And, one of the most important functions in this train of gears for any successful company is the method of "gearing engineering to sales."

The profitableness of a company's product depends upon the original profit margin anticipated actually being realized when the product is in the field and being used. No additional unexpected service calls should be attached to the product; and no replacement of it due to faulty design, beyond a reasonable percentage, should be necessary. The engineer should so design the product that it will be salable, simple in operation, and as near perfect as possible in performance. Confidence of the customer will be assured by good performance and repeated satisfaction from use.

LOW GEAR

In gearing engineering to sales, the two departments should start off in low gear by an understanding of each others' problems and a realization of the mutual dependence for their solutions. Jealousy between departments and between individuals in a department, buck passing, and backbiting must be eliminated. There should be a willingness to assume responsibility and to admit errors and mistakes as they occur. Finally, constant contact and discussion between heads of the two departments is necessary and helpful.

SECOND GEAR

The next step in setting the gearing between the engineering and sales department operating is to go into second gear which includes setting up a program of field analysis of the product. The sales department does its part by periodically checking the needs and requirements of the customers as well as the performance of products already in the field. Next to inquiries, complaints can be the most valuable element in the work of a salesman. Customers must be appeased and satisfied, and their complaints must be capitalized by immediate possible changes of the cause of the complaint.

From the engineering viewpoint, second gear demands an analysis of the field needs and performance by the engineering department itself. Frequently, an engineer may go into a plant and obtain an entirely different point of view or a different response from a customer from that of the salesman who is regularly calling on that account. It is necessary for the field engineers to have a patient and teaching attitude not only toward the salesmen with whom they come in contact but toward the customer himself. It is also a prime requisite to have competent personnel in the engineering department so that the sales department may get the kind of leadership and cooperation that it needs in time of trouble and to keep the product sold.

HIGH GEAR

Swinging into high gear, there must exist between the two departments not only a common purpose with competent personnel but also thoroughly defined functions for the personnel involved. No matter what differences may exist between the two departments' representatives, the proper company attitude must be manifested in the presence of the customer in order to create confidence in the company as a whole. Finally, it should not be forgotten that whenever a prospective customer talks with anyone from the organization, in his (customer's) opinion he is talking to the company, whether the representative is from the engineering or sales department. So, to promote sales, there must exist in the field a harmony of action.

SALES ENGINEERING

Sales engineering, as such, requires a particular kind of cooperation or gearing between the sales and engineering departments. In this case, the salesmen are engineers. Nevertheless, there is still need for contact and cooperation on the part of the sales engineers with the engineering department. All the foregoing points mentioned still hold good in this relationship. Usually, the sales element takes second place and engineering is paramount. Even though the engineer sells, he must rely upon his training of analysis, time study, ingenuity, and ability to plan sequence of operations by knowing the possibilities of different machines. Frequently, he must design a special or semispecial machine for a customer. In other words, he must meet and solve problems which require good, sound engineering sense.

Sales engineers talk in terms of cost per piece and, with this approach, frequently present a sales argument in the most alluring and convincing manner. They must also have an understanding of psychology, proper sales approach, and methods of presentation. Lastly, the proposal should be so well prepared that a superintendent or foreman can show the proposition to his superior in the sales engineer's absence and explain it as well as if the sales engineer were presenting it himself.

The author believes that emphasis must be placed on strictly engineering qualifications in a sales engineer, but given these qualities and these essentials, that engineer who has sales technique in addition will achieve greater success and better results.

GENERAL SALESMEN

In the case of general sales for an industrial company, the men are more salesmen than engineers. They must, however, have a full knowledge of the product, its uses and functions, and a complete engineering understanding of the product. These salesmen should have the capacity to interpret engineering functions into what the product will do for the user. Proper sales technique is essential and definitely needed. Most important of all, the proper sales tools should be used at the point of sale. It is possible to make all sorts of promotion plans and to equip the men with all kinds of sales literature, but if these are not used at the point of sale, they are of little value. It is the author's contention that many times there is a tremendous loss of worth-while sales ideas from their conception in the engineering and sales departments until the time they are ready for

presentation to the customer. This loss sometimes varies as much as 15 to 100 per cent.

CONCLUSION

In conclusion, the author wishes to make a few suggestions on this question of gearing engineering to sales. With the present upswing in business, the highly competitive market will become more so. There are rewards in the form of orders for those companies whose engineering and sales departments work together to attack the sales problem in the proper way. The head of the engineering department may do his part by getting closer to the sales manager and his problems, by becoming fully familiar with the field performance of both old and new products, by taking immediate action on the findings, by being fully alert to the demands for a better and for a more salable product, and by creating confidence in himself and in his department through capacity, performance, and results achieved.

Market Research in Introducing New Industrial Products

BY R. L. GIBSON

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

CHANGES in products, changes in markets, changes in marketing methods—all make market research necessary. If the products and services of industry were not improved constantly but remained always the same, if human wants were easily satisfied and unchanging, if we were all contented with what our fathers had and satisfied to live and work day by day as our fathers did, there would be no need for new products and for market research.

DEFINITION OF MARKET RESEARCH

Research is concerned with the discovery of truths, the collection of facts; market research has to do with the collection of facts on markets and marketing. Market research is easily understood if it is remembered that it is the reverse of advertising. Advertising gives out information from one central point to many people. It uses various media (magazines, radio, mail, newspapers) the selection of which depends upon (1) the message and (2) the people to whom the message is directed. Market research attempts to get information from many people and bring it back to one central point. Likewise, many different media are used (mail surveys, personal calls, telephone surveys), depending (1) upon the information needed and (2) the people from whom it can be obtained.

Market research, like most things in life, is fundamentally simple, and only becomes complex when people try to improve it to a high degree of efficiency. For example gasoline engines and steam turbines are simple, fundamentally, but have grown complex in our efforts to improve them.

INTRODUCTION OF NEW PRODUCTS

Perhaps the most ideal form of market research is that which attempts to discover the latent needs in industry, commerce, and the home, and from these needs discovers what new products should be developed. Such studies are the "pure science" of market research and, unless a manufacturer has a large market-research staff, are likely to be somewhat impractical. However, many market studies may reveal the need for new products even though their principal objective be in another direction. For example, a recent statistical analysis of the domestic-heating market disclosed the need for a new product in the line of equipment which is offered for sale in the warm-air field. This need, it was found, had been recognized from time to time by the company's engineers as well as by those of other companies, but the extent of the opportunity which a possible new product might offer had not been realized. Market research served to point out the extent of the opportunity.

Market research is most useful in the introduction of new products when it helps find the answer to specific questions which naturally arise, such as:

1 Does a market exist for this new product?
2 If not, can a market be created?
3 What volume of business can be expected?
4 What competition will the product have?
5 At what price should the product be offered for sale?
6 What design features do customers want?
7 Through what sale channels could the product be sold most effectively?

KEY QUESTIONS

Just as a lawyer attempts to get to the "key" point in his case (the point on which the case may be decided), so does a market-research man attempt to select those few questions which are of greatest importance and likely to be "key" questions.

The importance of selecting the right questions is emphasized by the fact that it is seldom if ever practical to attempt a complete market study. There are so many angles to every product, so many questions to be answered, that to get all the facts having a bearing on the development and marketing of one product would require years of work, so many that some of the data would be out-of-date before they were used.

When an engineer or a sales manager asks if market research can help with a particular situation, in other words, when the time comes to select the key questions, it is well to consider the problem from the viewpoint of the five factors which must be right for the successful marketing of a product. These five factors are, the company, the market, the product, the sales organization, and the advertising.

These five factors must all be right if there is to be continued sales success and no weak links in the chain. Several years ago, during a year when most automobile manufacturers were operating successfully, two manufacturers were at that time operating unsuccessfully. It was discovered that, in the case of one company, the product was apparently right, the company was right, the market was certainly right, but that manufacturer lacked a sufficiently strong sales organization. In the case of the other manufacturer, the company was right, the market was right, the sales organization was right, but the product itself was not acceptable to the public. The reader can no doubt draw from his own experience many similar instances.

EXAMPLES OF QUESTIONS

So it is seen that the first step is to decide what questions are of foremost importance. To illustrate what some of these questions are, and at the same time to show the reader that market research can be a practical everyday tool of help in connection with new products, the author gives the following examples from his company's experience:

Plastic Tray. The problem with this product was typical: "Is the market sufficiently large for this type of tray at the price which would have to be asked?" A secondary question asked: "Would the restaurant market welcome a special silver inlay in the base of the tray of a design of the customer's selection?" It was interesting to learn not only the size of the market, but

also that the restaurant people cared nothing for inlaid designs; the features they wanted most were quietness and ease of cleaning.

Photoelectric Control. The market-research groupin the author's company was asked to find out the location of the best markets for photoelectric control devices. The problem, therefore, was to evaluate application opportunities, principally through studies of existing applications.

Instruments. With certain small instruments the problem was one of design. It was discovered that the company's product was unnecessarily accurate for certain sections of the market, and, therefore, too high a price had to be charged. It was also discovered that appearance was often more important than accuracy, and that sales efforts were not being directed toward the best markets.

Garbage Grinder. This device, sometimes called the "electric pig," presented an interesting market-research problem. (For further details see "The Development of New Products," by A. R. Stevenson, Jr., MECHANICAL ENGINEERING, September, 1939.) It was requested that the company's market-research group estimate how many might be sold at a certain price. However, a limitation imposed was that the identity of the product could not be revealed in the interviews even though some indication was required as to how many people would buy it. Therefore, incinerators were studied. People owning incinerators were asked why they bought them and if they were satisfied. The survey revealed that the price would have to be reduced on the garbage grinder in order to sell even a few. The price was cut and actual sales followed the estimates with surprising accuracy.

Mercury Turbines. After large mercury turbines were designed, a market study was made to determine the opportunities for selling various sizes of smaller turbines of the same type. The survey revealed a large demand for one of the sizes of turbines studied.

Many more examples could be cited. The du Pont Company has used market research extensively in introducing cellophane. Studies were made, for example, of house-to-house selling methods used by bakeries with operations timed by stop watches and, as a result, a sales plan for bakeries was developed. The Eastman Kodak Company has surveyed, through camera clubs, advanced amateur photographers, to learn their needs, experiences, and habits. The Parker Pen Company made a field survey on fountain pens and discovered a preference for pens in bright colors. A radio manufacturer conducted a door-to-door survey to determine the consumer preference as to various models of radios in its line and was able to gage the models desired within one per cent of the preference later indicated by orders which were received.

Market research is also used by the Cincinnati Milling Machine Co., General Foods, Norge, Shell Oil, and many others. It is the author's observation that those companies which have large research laboratories nearly always have market-research organizations, such as General Motors, A.T.&T., Eastman, du Pont, and Goodyear. Incidentally, the author believes that a market-research group might well be referred to as a "sales laboratory."

MARKET-RESEARCH METHODS

Such polls as those by Dr. Gallup have become so popular and so talked about that most people know the principles involved in sampling, and questionnaires. Each fact, of course, must be studied in its relation to every other fact, and psychological factors must be handled in a special way. To ask a customer *why* he buys a certain product is usually considered to be a poor question. The customer can probably tell the questioner accurately whether or not he buys that particular product, where he buys it, and other such things. But he may not know why he buys it; therefore, a series of questions must be asked in order to find out what influences have been brought to bear on the customer, and the attributes of the product. From the answers to such questions it is usually possible to find the reason *why*. There are mistakes in market research just as there are in other things. Market research is not a cure-all and has definite limitations which must be learned.

CONCLUSION

Gantt once said that "man has no moral right to decide anything on the basis of opinion which can be decided on the basis of fact." In helping to collect facts, market research is a practical tool which can be of real help in the introduction of new industrial products.

ACKNOWLEDGMENT

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Cushing, New York

FOREST-FIRE BEHAVIOR STUDIES

By JOHN R. CURRY and WALLACE L. FONS

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GENERAL principles of forest management were established over 200 years ago in Central Europe and the task of the American forester has been largely to adapt these principles to the management of the vast, rough, and inaccessible natural forests of this country. A series of essentially new problems has arisen, however. In the humid climate where forestry originated, forest fires are relatively rare and unimportant, while in the New World, fire protection is the most serious of all problems facing American foresters. This has necessitated the development of methods of investigation for which there is little precedent.

ORGANIZATION OF FOREST PROTECTION

A brief description of the protection problem in the national forests of California will serve to exemplify the problem in the nation as a whole. The national forests comprise about 19,000,000 acres, approximately 20 per cent of the State of California. Each year these forests are subjected to a period of drought lasting from 4 to 6 months, during which the natural debris and dead undergrowth become tinder dry. Atmospheric lightning accounts for about 40 per cent of the annual total of 1500 fires, while man and the works of man account for the remainder.

Efficiency in forest-protection organization has increased steadily since its inception in 1905. It is now the practice in all forested areas to post guards in lookout towers throughout the summer season for the purpose of detecting and reporting the smokes of forest fires. Communication lines lead to centers where fire dispatchers locate fires accurately by triangulation. Forest guards, tank trucks, and suppression crews are strategically located to provide a minimum travel time to fires. Costs must be kept to a minimum, as only approximately 3 cents per acre per annum is provided for direct expenditure on forest protection. Over 95 per cent of all fires are controlled in their incipient stage, but a few, because of rapid initial spread, attain a size in excess of the strength of the initial crew, and become large, damaging, and expensive. Occasional fires reach 10, 20, or even, in rare instances, 200,000 acres. The elimination of these large fires is the present principal problem of all forest-protection agencies. The total average yearly cost of forest fires in California, $1,500,000, could be reduced to one third or less, if all fires were confined to a maximum of 300 acres.

Many forest-protection problems remain unsolved after 35 years of work. A few general principles have been developed, but little fundamental information is available to guide planning and management in fire control. In this respect, it is far behind such older branches of forestry as silviculture, forest utilization, and protection of forests from insects and tree diseases.

Fire behavior is a general term covering all natural forest-fire phenomena of importance from the standpoint of fire protection. These include ignition of forest fires, their spread, crowning, and spotting. Of prime importance to forest protection are the first problems, fire ignition and fire spread; ignition because it largely controls the occurrence of fires, and spread because it governs size which fires may attain during any time interval.

Other investigators, notably Gisborne (1),[1] Stickel (2), and Wright (3), have studied ignition and its influence on fire danger. Show (4) made a preliminary study of fire spread 20 years ago and, in the last 6 years, his work has been continued and extended by the California Forest and Range Experiment Station.

The study of fire spread consists in the recognition of the variables controlling this phenomenon, in developing methods and techniques of measurement, and finally in evaluating the influence of all relevant variables, both individually and jointly, on the rate of spread. The goal of this study is a precise method of estimating the size to which a fire would grow under any natural conditions within a given time. Solution of this problem would have immediate application in establishing the necessary speed and strength of attack for successful suppression.

General experience in forest-fire control, the early work of Show (4), and theoretical studies by Hawley (5) and Gray (6) demonstrate at least four independent primary variables affecting rate of spread: (*a*) Fuel, its composition, size, and arrangement; (*b*) fuel moisture; (*c*) air movement or wind velocity; and (*d*) topographic slope. In addition to these, there are several secondary factors such as air and fuel temperatures, atmospheric humidity, air oxygen content, and, possibly, others still unrecognized. The theoretical analyses indicate, however, that the major fluctuations in rate of

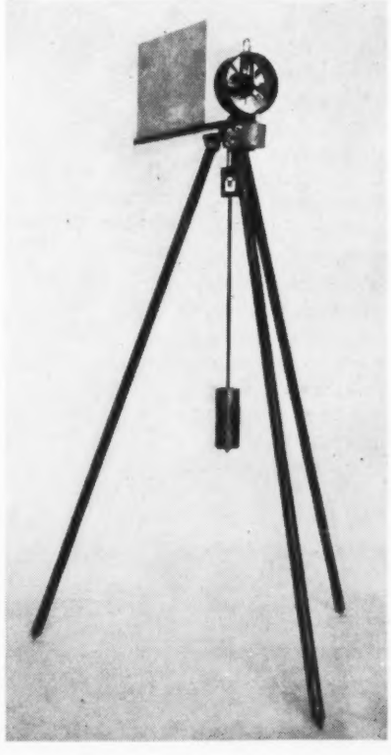

FIG. 1 VANE ANEMOMETER MOUNTED ON SPECIAL TRIPOD AND FITTED WITH DIRECTION VANE

Presented at the Semi-Annual Meeting San Francisco, Calif., July 10–15, 1939, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

FIG. 2 TEST FIRE IN EVEN-AGED STAND OF PONDEROSA PINE; 8 MIN AFTER IGNITION

spread of fires under natural conditions may be largely explained by fluctuations of the four major factors listed, namely, fuel, fuel moisture, wind, and slope.

TEST FIRES UNDER FIELD CONDITIONS

Preliminary studies (7) consisted of observations of fire spread under natural conditions of fuel, weather, and topography. It appeared desirable to attempt to investigate rate of spread first by means of test fires set in one simple uniform fuel type where measurements of all other variables could be made.

The ponderosa-pine type was chosen for these early experiments because this type grows occasionally in dense stands with quite uniform needle litter. Fires in this type spread as surface fires comparatively easy to control. During two summers of field experimentation in pine litter, 300 fires were studied, 250 on surfaces of less than 5 per cent slope.

Six primary measurements were made on all test fires, viz., (*a*) fuel depth, (*b*) moisture content of fuel, (*c*) wind movement, (*d*) slope of the ground, (*e*) elapsed time from start, (*f*) perimeter at elapsed time intervals. Fuel moisture was determined by gathering a sample of top needles, selected at random over the entire surface of the plot, weighing the sample immediately, and later drying to a constant weight in an oven held at a temperature of 90 C. Wind velocities were measured at a height of 2.5 ft from the ground by means of the vane anemometer shown in Fig. 1. Perimeters of the fire were plotted every 2 min on polar-coordinate paper by reference to steel stakes set at regular intervals on lines radiating from the point of ignition. Fig. 2 illustrates a fire 8 min after ignition on a typical test plot.

Fig. 3 illustrates the type of fire chart obtained in this study, for zero wind, and Fig. 4 for a wind of constant direction. Moisture content varied from 3 to 13 per cent, the normal range during the seasonal drought period. The range of wind velocity was from zero to a maximum of 5 mph. Winds higher than 5 mph are rarely experienced near the ground floor in closed pine-forest stands, although concurrent velocities above the trees or in the open would attain as much as 30 mph.

The data were analyzed by combining for each 2-min interval the measurements of perimeter increase, fuel moisture, wind velocity, elapsed time, and, where important, slope. The maximum time period considered was 22 min, as observations over a longer time were meager. The data were plotted and smoothed on each variable, utilizing the method of successive approximations and finally, as an empirical expression for the functions, were obtained equations of the type

$$\left(\frac{dP}{dt}\right)_t = a + bM + cV \quad \ldots\ldots\ldots\ldots [1]$$

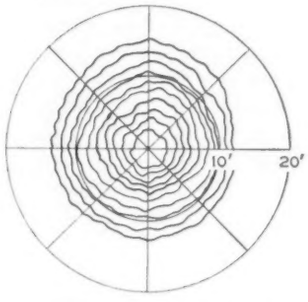

FIG. 3 TYPE OF FIRE CHART OBTAINED FOR ZERO WIND
(Diagram of slowly spreading fire; wind velocity, zero; fuel moisture content, 7 per cent; perimeters shown at each 2-min interval.)

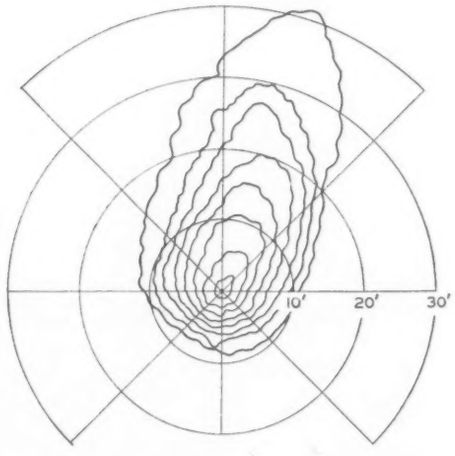

FIG. 4 TYPE OF FIRE CHART OBTAINED FOR WIND OF CONSTANT DIRECTION
(Diagram of rapidly spreading fire; wind velocity, 2 mph; fuel moisture content, 4.3 per cent; perimeters shown at each 2-min interval.)

in which $(dP/dt)_t$ = rate of increase of perimeter fpm at time t

V = average wind velocity during interval, mph
M = moisture content of fuel, per cent
a = 6.35 for all time intervals
b and c = quantities which are constant during any particular time interval.

Equation [1] describes the influence of both wind velocity and fuel moisture as linear, a relation which appears well established within the limits of moisture content and wind velocity investigated.

It is apparent that, for any values of wind and moisture within the range of the data, it is possible to calculate the total perimeter for any time up to 22 min from the relationships expressed in Equation [1]. This may be accomplished by summing up the rate equations for each consecutive interval to get

$$P_t = at + BM + CV \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

where, P_t = total perimeter at time t
B = Σb, the sum of all values of b up to time t
C = Σc, the sum of all values of c up to time t

The values of B and C are given in Table 1. Fig. 5 illustrates the manner in which total perimeter increases with time.

TABLE 1 *B* AND *C* VALUES FOR CALCULATING TOTAL PERIMETER BY EQUATION [2]

Time, min	*B*	*C*	Time, min	*B*	*C*
2	0.69	0.52	13	4.85	16.44
3	1.04	1.26	14	5.26	18.33
4	1.40	2.26	15	5.68	20.27
5	1.76	3.46	16	6.10	22.25
6	2.13	4.79	17	6.53	24.27
7	2.50	6.23	18	6.96	26.32
8	2.88	7.76	19	7.40	28.40
9	3.26	9.37	20	7.85	30.51
10	3.65	11.05	21	8.30	32.65
11	4.05	12.79	22	8.75	34.81
12	4.45	14.59	..	...	...

To test the accuracy of the linear expression of perimeter increase as a function of moisture content and wind velocity for this pine-needle fuel, the perimeters of 118 fires were calculated by use of Equation [1] and compared with the observed values for all 2-min intervals. The results of these calculations are given in Table 2, in which the accuracy of the calculated values is expressed as a standard error in both feet and per cent.

TABLE 2 SUMMARY OF ACTUAL AND CALCULATED TOTAL PERIMETERS OF TEST FIRES

Time, min	Cases, no.	Average perimeter— Actual, ft	Calculated, ft	Standard error of estimate— Ft	Per cent
2	118	7.5	7.6	2.1	28.0
4	118	17.7	17.7	4.5	25.4
6	118	28.9	26.8	6.2	21.5
8	118	40.0	40.0	9.4	23.5
10	118	51.2	51.6	11.1	21.7
12	117	63.5	63.0	13.7	21.6
14	114	75.4	74.7	16.0	21.2
16	109	87.0	86.1	16.5	19.0
18	96	97.7	96.5	19.2	19.7
20	71	102.3	102.8	17.2	16.8
22	56	112.6	112.6	19.7	17.5

This analysis showed that with the methods used, the total perimeter of small fires could be estimated with a standard error of about 17 per cent. This error is attributable to (*a*) variations of the fuel, which were not measured; (*b*) variations in fuel moisture not fully accounted for; (*c*) methods of measuring wind not wholly satisfactory; and (*d*) secondary variables not considered.

DETAILED STUDY OF VARIABLES

Fuel moisture was known to vary from place to place on the plots, and these variations were not evaluated in the sampling technique used; furthermore, the method of determining fuel moisture was unreliable for the degree of refinement required. Wind values, although reliably accurate, were not readily applicable to fire-control practice because the relation between measurements inside the stand and customary measurements in the open were not available. Consequently, it was decided to study all important elements individually prior to any attempt to extend the field studies to other more complex fuel types. Pursuant to this plan, the following studies are now being made:

1 Methods of sampling fuels for moisture content and of analyzing for fuel moisture.

2 Wind movement in forest stands and its correlation with movement in the open.

3 Influence of fuel variables, including size, arrangement, and composition, on rate of spread.

Fuel Moisture. Because of the large influence on rate of burning of small changes in moisture content, it was essential to develop a more accurate method of measuring fuel moisture.

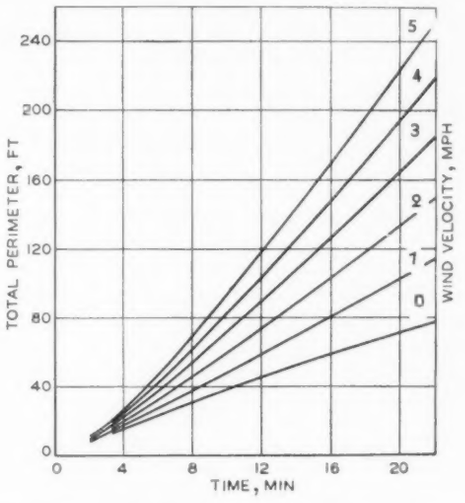

FIG. 5 TOTAL PERIMETER WITH TIME; VARIOUS WIND VELOCITIES; MOISTURE CONTENT, 7 PER CENT

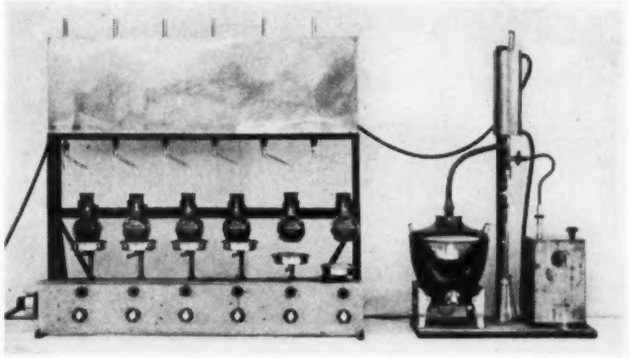

FIG. 6 MOISTURE DETERMINATION AND XYLENE-RECOVERY APPARATUS USED IN FIRE-BEHAVIOR STUDIES

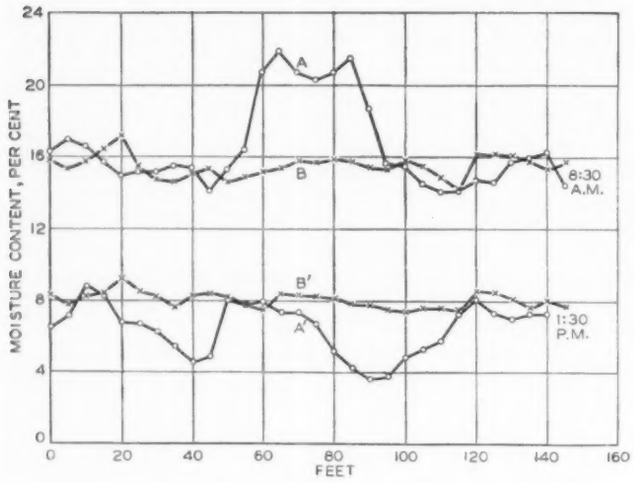

FIG. 7 TYPICAL FUEL-MOISTURE VARIATIONS AS FOUND IN OPEN AND CLOSED STANDS

(Variation in moisture content of pine litter at 8:30 a.m. and 1:30 p.m. on a 150-ft strip 5 ft wide; samples taken at 5-ft intervals. *A-A'*, open stand; *B-B'*, closed stand.)

Erratic behavior of fuel samples in well-designed drying ovens demonstrated that this method could not be relied upon for determining moisture content more closely than to the nearest 2 per cent. Recent investigations by Buck and Hughes (8) resulted in the development of the xylene-distillation apparatus, Fig. 6, by which results could be duplicated within a consistent range of approximately 0.2 per cent. This precise method has been a boon to the detailed investigations of other variables.

During the fire season, variations in the moisture content of typical forest fuels are influenced mainly by fluctuations in atmospheric humidity, and also by dew and soil moisture. By sampling transects in pine stands of varying densities, principles basic to the selection of test plots of uniform fuel moisture, and to the sampling of test plots for reliable mean moisture estimates, were developed. Typical variations as found in open and closed stands are illustrated in Fig. 7.

Currently this study is being extended to obtain data for the correlation of fuel moisture with precipitation, relative humidity, wind velocity, temperature, and soil moisture. Also an investigation is being included of seasonal and diurnal variations in moisture content of the green foliage of certain common brush species in which rate-of-spread studies are contemplated.

Wind in Forest Stands. Studies of wind movement are a necessary part of rate-of-spread investigations to permit determination of the proper location of anemometers on test fires and correlation of wind velocities within the forest stand with measurements made by standard anemometers in the open. Such studies have produced new and valuable information on the relation of wind velocities to height in forest stands and in open grassland. Fig. 8 shows wind intensity in relation to

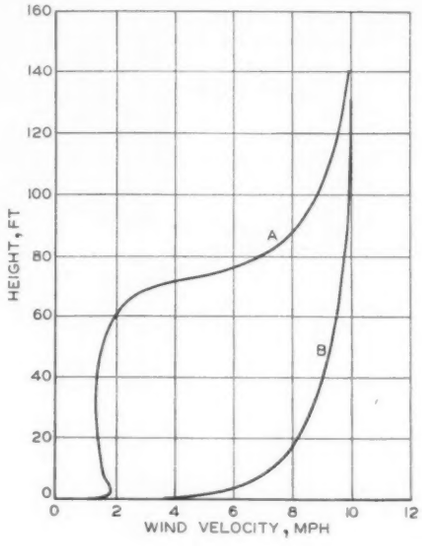

FIG. 8 WIND VELOCITY IN RELATION TO HEIGHT

(*A*, Even-aged coniferous forest, 70 ft high; *B*, open grassland.)

height in a moderately dense coniferous forest as compared to an open grassland. It may be noted from curve *A* that the wind intensity is decreased enormously at the tops of the trees at 70 ft and is nearly constant in the canopy. These experiments have provided a basis for converting stand wind intensities to

FIG. 9 TYPICAL NORTHERN CALIFORNIA BRUSH FUEL

intensities in the open and have shown the arbitrary height of $2^1/_2$ ft originally adopted for anemometer exposure in closed stands to be satisfactory for future work.

Fuel Study. Determination of the effect of fuel is of major importance to the rate-of-spread problem. The immediate aim of these fuel studies is to ascertain the pertinent variables and to develop methods for their measurement.

Forest fuels may vary from a uniform needle litter in pure coniferous stands, Fig. 2, through dense uniform brushfields, Fig. 9, to uneven-aged mixed stands where little or no physical uniformity in fuel is apparent. Fuels thus exhibit great differences in such physical characteristics as size, shape, and surface texture.

In considering a simple fuel condition such as that presented by pine needles or dead grass, two types of fuel variables may be distinguished, those of the fuel particle and those of the fuel bed. The fuel in these cases is a thin elongated particle the dimensions of which are amenable to measurement and expression, and these dimensions are in part responsible for the speed of propagation of the fire. On the other hand, fuels in the forest naturally occur as beds of particles compacted to various degrees by rain, snow, and weathering. This compactness is characteristic not of the fuel particle but of the fuel bed, and exerts, independently of the particles, its influence on fire propagation. Accordingly, fuels of this simple sort may be studied from two standpoints, first, as individual particles of different dimensions, and second, as beds of different compactness.

TABLE 3 DENSITY AND SURFACE AREA FOR SEVERAL TYPES OF FUELS

Fuel type	s Sq in. per g	γ G per cu in.	σ In.$^{-1}$
Ponderosa-pine needles	15.4	8.3	128
Lodgepole-pine needles	15.1	9.3	140
Sugar-pine needles	18.7	8.8	165
Ponderosa pine, 0.036-in-sq stick	15.7	7.0	111
Ponderosa pine, 0.044-in-sq stick	12.8	7.0	90
Ponderosa pine, 0.062-in-sq stick	9.1	7.0	64
Ponderosa pine, 0.101-in-sq stick	5.6	7.0	39
Ponderosa pine, 0.245-in-sq stick	2.3	7.0	16
Poplar excelsior	40.0	6.2	248

FIG. 11 MINIATURE EXPERIMENTAL FIRE IN PINE-NEEDLE BED

Fuel-Bed Experiments. It is common knowledge that, for rapid burning, fuel must be piled loosely. This increases the proportion of air spaces or voids which influence the oxygen supply and the distribution of radiant energy. The exposed fuel surface affects the rate at which heat is absorbed and, hence, the rate at which progressive ignition takes place. The ratio of voids to fuel-surface area has been hypothesized as the fuel-bed variable controlling the rate of flame pro-

FIG. 10 PINE-NEEDLE BED PREPARED FOR MINIATURE-FIRE EXPERIMENT

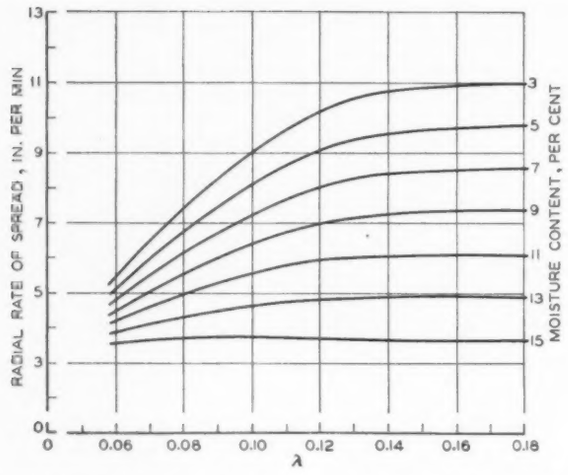

FIG. 12 RADIAL RATE OF SPREAD AS A FUNCTION OF λ FOR VARIOUS MOISTURE CONTENTS IN PONDEROSA-PINE NEEDLES; $\sigma = 111$

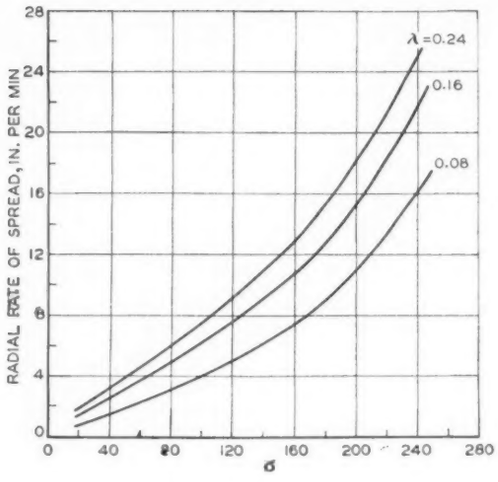

FIG. 14 RADIAL RATE OF SPREAD AS A FUNCTION OF σ, FOR THREE VALUES OF λ

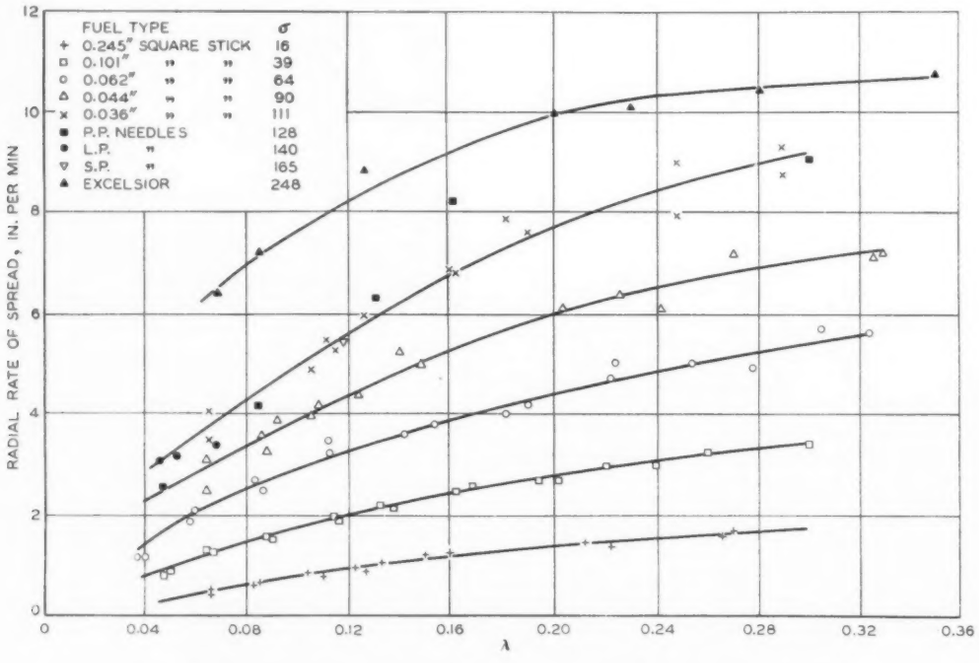

FIG. 13 RADIAL RATE OF SPREAD AS A FUNCTION OF λ FOR SEVERAL FUELS
(Moisture content 8.8 ± 1 per cent. Radial spread for excelsior divided by 2.5.)

pagation. This ratio may be expressed in terms of known quantities as follows:

$$\lambda = \frac{1}{Ws} - \frac{1}{\gamma s}$$

where for unit volume of the fuel bed

λ = volume of voids per fuel-surface area
W = dry weight of fuel
s = surface area per unit weight of fuel
γ = density of fuel.

To utilize this equation, it is necessary to determine s and γ for the individual particles comprising the fuel bed. This has been done for several types of needles and artificial fuels as shown in Table 3.

To test the hypothesis that rate of spread is a function of λ miniature fires were set in prepared beds of ponderosa-pine needles, Fig. 10, holding the fuel particle constant but varying λ and moisture content. Each fire was allowed to burn to 18 in. diam, and the radial rate of burning in inches per minute was computed. A typical fire is shown in Fig. 11. The combined effect of λ, moisture content, and rate of spread, which were obtained from 450 miniature fires, is presented in Fig. 12. It may be noted that the rate of spread varies regularly with λ but that, at high moisture value, its effect becomes unimportant.

Fuel Particle Experiments.[2] It is a matter of common observation that fineness in fuels promotes rapid combustion. Physically, the essential difference between fine and coarse fuel is the surface area per unit volume, hereafter designated by the

[2] Experiments were conducted by R. K. Blanchard, California Forest and Range Experiment Station.

symbol σ, and this has been tested as the fuel-particle variable governing rate of spread. This was done in a second series of miniature-fire experiments in which λ and σ were varied but with moisture content held constant within 1 per cent. The following fuels were used: (*a*) Ponderosa-pine sticks of square cross section; (*b*) hardwood excelsior; and (*c*) pine needles. The values of σ for these fuels are given in Table 3.

Fig. 13 shows rate of spread of individual fires plotted as a function of λ for these several fuels. The curves of Fig. 14 were obtained by cross-plotting curves of Fig. 13. They indicate that, in so far as these relatively simple fuels are concerned, the attribute of the fuel pertinent to the rate of spread of surface fires is simply and adequately expressed by considering as independent variables, surface area per unit volume σ, and voids per unit area λ.

All experimental fires to date have been conducted with zero wind. To extend these tests over the normal range of forest wind velocity, a wind tunnel, Fig. 15, has been constructed, capable of producing wind velocities up to 15 mph. Future research is also contemplated in the more complicated fuels of brushfields and mixed stands.

CONCLUSION

Although this field of study is new and progress has not been great, the results are already being utilized in the solution of fire-control problems. A systematic method of rating fire danger on all California national forests has been developed in part from these studies. Under this method, fuel moisture, wind velocity, relative humidity, and other important fire-behavior variables are currently measured and integrated into a series of indexes expressing, relative to normal summer conditions, the chance of fires starting, their rapidity of spread, and, finally, the type of organization required to cope with current fire danger. Under this system, guards and other fire-suppression forces may be increased to 5 times normal for extreme conditions. The system developed has an advantage over most other fire-danger rating systems in being based partially upon studies in fire behavior.

Progress in rate-of-spread studies will undoubtedly be slow. The program can be advanced best by research in other localities and by new suggestions in approach. Of particular importance is the solution of the problem of describing and measuring the fuel variable. Upon the solution of this problem rests the possibility of broad generalization in regard to rate of spread of forest fires.

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FIG. 15 WIND TUNNEL FOR FIRE-BEHAVIOR STUDIES

(Since this photograph was taken the test section of the wind tunnel has been lengthened by twelve feet to eliminate entrance disturbances.)

Basic ENGINEERING FACTORS *in* AGRICULTURAL TECHNOLOGY

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THE TERM agricultural engineering implies the application of engineering knowledge and technics to agricultural production and processes. The processes and operations of agriculture differ from those of other industries. Five essential but not necessarily independent differences will be noted: (*a*) The biological variable; (*b*) the direct dependence of the industry upon the climatic conditions in the immediate vicinity and also upon those conditions which exist in distant regions, in the case of irrigated lands; (*c*) the seasonal character of some of the activities and the short period available to accomplish the tasks, with a consequent low load factor on some machinery and equipment; (*d*) a decentralized industry which is evolving in the direction of cooperatives, voluntary regulation and large centralized units; (*e*) power must be taken to the work rather than the work taken to the power plant.

Agriculture is concerned primarily with the production of raw products for food (grain, fruit, meat, vegetables), for shelter (lumber, fibers), for clothing (textiles) and, to a partial extent, for industrial purposes (newspaper pulp, linseed and soybean oil, plastics). The unit operations (1)[1] of agriculture, as applied to the raw material are chopping, grinding, baling, siloing, drying, cooling, washing, sizing, storing, and transporting. These processes are usually carried out in the field. In many cases, however, centralization is being effected (fruit drying) and natural forces are being replaced by artificial forces (kiln hay driers, employing coal or oil, are replacing sun curing).

Great and splendid changes have been wrought in agriculture in the span of a lifetime. In many operations man power was first replaced by horse power. Mobile machinery, capable of several operations, was created and has been utilized by many farmers. Then a second change in the source of mobile power and stationary power (including electrical) appeared on the horizon. Farm machinery was slowly adapted to the tractor. However, many tedious hand operations remain and the adaptation of other machinery to the horse and tractor as a source of power is incomplete. The application of the modern technics of engineering to agricultural processes presents a challenge to engineers. An improvement of the status of the farmer should result from this effort, thus reducing the unbalance which now exists between agriculture and the remainder of industry. Effective work in this connection is being done in the various agricultural experiment stations and in the agricultural industries. To demonstrate the lines along which developments are taking place, a few examples will be cited from among the multifarious activities of the Division of Agricultural Engineering, University of California.

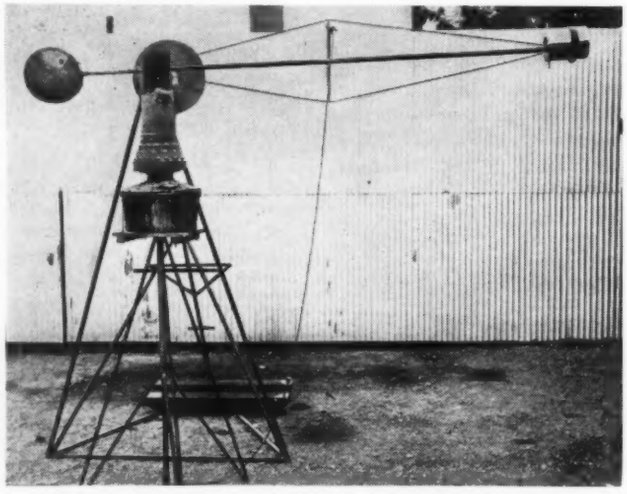


FIG. 1 BOWL-TYPE ORCHARD HEATER IN POSITION FOR MEASUREMENT OF SPACE DISTRIBUTION OF RADIANT ENERGY

(The radiometer is in extreme upper right-hand corner.)

Orchard Heating. This activity (2, 3) may be recognized as a problem in micrometeorology. Heat is lost from the orchard by nocturnal radiation or by convection to a cold air mass. This loss of heat must be partially supplied by artificial means. Various methods have been proposed, the most widely used being the oil-burning orchard heater. Evaporation, drip, and generator types (4) are employed and each involves cracking, polymerization, oxidation, and incomplete combustion of the fuel with the resultant formation of heavy ends, deposited carbon, and smoke. In the evaporation type, Fig. 1, radiant energy from the lower part of the flame heats the surface of the oil which vaporizes and, in the conventional type, is mixed with some cold air. In addition, some heat is generated by the pilot flame. The mixture is extremely rich as it approaches the flame front. The development by Leonard introduces inert diluents (stack gases) (2, 5) into the bowl above the oil, which has the effect of separating the hydrocarbon molecules and reducing the tendency to form carbon upon combustion.

Measurements of solar radiation, earth irradiation by the atmosphere, temperature, humidity, and velocity gradients in the atmosphere from 0 to 500 ft, soil temperature gradients and soil heat-flow rates are being made. Two control orchard plots, one unheated, the second heated in a standard manner, are being compared with a third experimental plot in which the manner of heating is changed. Fruit, leaf, and shelter temperatures are noted. The effectiveness of radiant versus convective heating, as a function of the "local weather," has been determined preliminarily. Data are available yielding the "shape factor" of trees of different sizes with respect to various heater forms. The shape factor defines the fraction

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Presented at the Semi-Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, San Francisco, Calif., July 10–15, 1939.

of the energy originally radiated from the first body which will be incident upon the second.

Low humidities reduce the irradiation of the earth by the atmosphere (6) (the water vapor, carbon dioxide, ozone, dust, smoke, and liquid-water content), thus causing the air near the earth and cover crop to cool. The air temperature increases with elevation, often as much as 20 F in 50 ft for a relatively still atmosphere. Methods of moving this warm-air supply down to the trees have been studied in the field (7). The availability of convected energy from individual heaters is reduced because the thermal buoyant forces increase the elevation of the heated gases above that of the trees. Recovery of this thermal energy presents an intriguing problem.

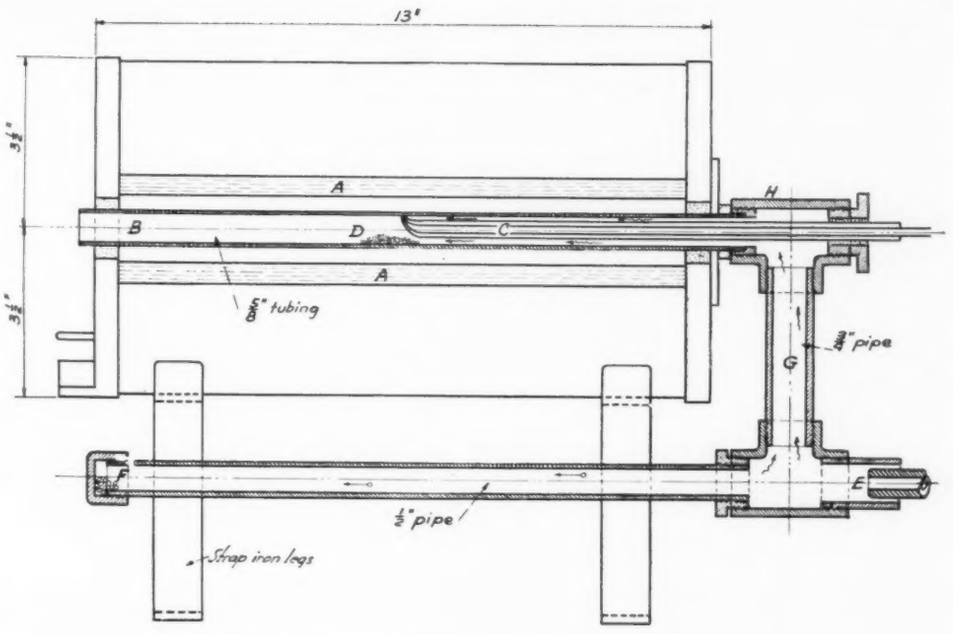


FIG. 3 PORTABLE FURNACE AND PARTICLE EJECTOR

Incidental to the work on heaters, a series of tests was made which fixed the pressure drop in a pipe line in which two components, one a liquid, the other a gas, were flowing simultaneously (8), but were not emulsified. Measurements yielded the information that the pressure drop for combined flow in a horizontal pipe was much greater than for the single component. For an air-oil weight ratio of 0.3, the pressure drop was five times that for the corresponding weight rate of air flowing alone. An interesting test revealed that the pressure drop in a wetted pipe exceeded that of the same ½-in. dry pipe by approximately 40 per cent.

Sugar-Beet Machinery. The production phase of the beet-sugar industry involves the operations of planting, thinning, cultivating, hoeing, and lifting. Raw processing includes the removal of the tops and then recovery and preservation. In addition, the beets must be removed and separated from the ground. This operation is now manual and requires 90 man-hr per acre. Finally, the beets must be transported to the factory (a possible temporary storage period may be included) by truck and rail, usually involving reloading at the beet dump. Laboratory tests on an experimental chain-feed single seeder and a commercial plate planter yielded distribution spacing which approximately follows the Gaussian function.

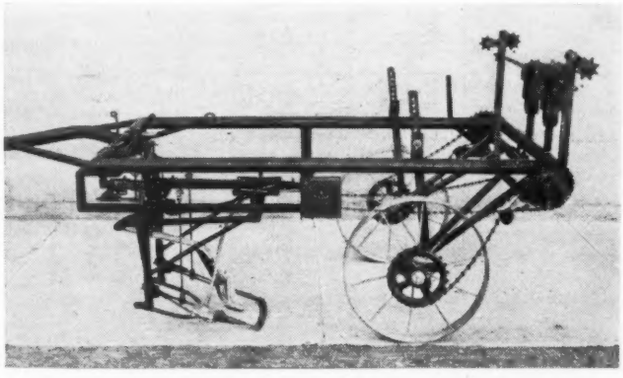


FIG. 2 VIBRATING-KNIFE BEET TOPPER, EXPERIMENTAL MODEL

A definite contribution to topping has been made as a result of the vibrating-knife variable-ratio field topper shown in Fig. 2. A horizontal knife is vibrated at the optimum frequency and amplitude for a given forward velocity through the work of given physical characteristics. The optimum operating conditions (amplitude times frequency) which would cut the beet (not break it) were determined by the measurement of the force required to move the knife through test beets, which varies with the forward velocity to the 0.75 power and should be less than 25 lb. The knife is excited by means of an eccentric driven from the wheels of the topper.

Field measurements yielded the result that the distance from the top of the beet (the contour followed by the finder) to the datum (the mean between the furrow and the ground adjacent to the beets) varies almost linearly with, but at a greater rate than, the distance from the lowest leaf scar to the ground datum. A variable-cut mechanism was devised. Field tests yield extremely favorable performance, the per cent top tare and the per cent topping loss being comparable to hand topping. Preliminary work on an improved beet remover has been done and other phases of the problem are being studied.

Electrical Soil Heating. A method of heating soil in which a wire carrying current was placed near the roots (or seeds) was studied (9). Many variations, including protected and open beds, were a part of the test agenda. A typical result will be presented. Gladiolus (10), in an open bed, bloomed from 2 to 6 weeks sooner if the soil near the roots was maintained between 60 and 70 F. An analytical solution will yield the temperature distribution in the soil due to the electrical heating. This solution is due to Kelvin who presented an analog, namely, the electrostatic field surrounding a conductor.

Spark Arresters. Small carbon or dust particles ejected from internal-combustion engines and stacks often constitute a fire hazard. A portable tube furnace shown in Fig. 3 was utilized to heat particles to predetermined temperatures. The particles were directed at the dried vegetation which was found on the ground. Particle sizes were identified in accordance with Table 1. Briefly, fires were consistently started in dry vegetation (8) by carbon particles sizes Nos. 1, 2, and 3 at initial temperatures of from 1500 to 1600 F during normal sum-

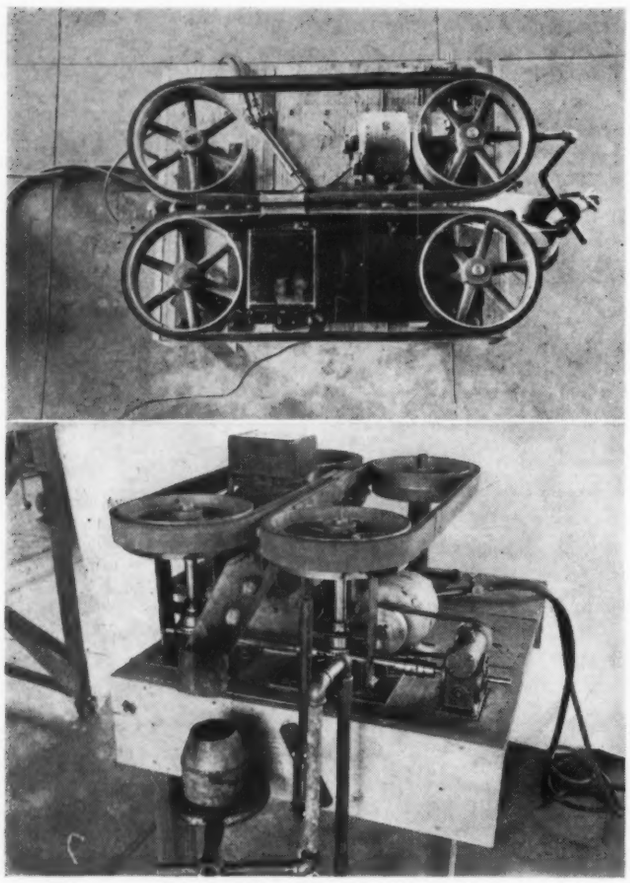


FIG. 4 COMBUSTION NUT CRACKER

mer conditions in California. In extremely warm dry weather, fires may be started at particle temperatures as low as 1300 F. Fires may be initiated with particles size No. 4 at an initial temperature of 1500 F under favorable conditions. Size No. 5 would, at the same temperature, start a grass fire on a very dry hot day (low humidity) near the point of ejection. The most effective spark arresters caused the least back pressure on the exhaust system and eliminated about 98 per cent of the particles up to and including size No. 4.

Processing of Walnuts. Among the unit operations to which walnuts are subjected, drying and cracking will be noted. The pressure drop through bins of walnuts has been studied by Moses (12). Comparison of the results with those of Furnas on the pressure drop through broken solids was made.

One half of the 70,000,000 lb of walnuts produced annually in California are sold as shelled nuts. The cracking process is tedious. Hand labor produces 35 lb of meat per worker per day. The nut cracker, illustrated in Fig. 4, was devised to accelerate and improve the cracking process; incidentally, approximately 60 per cent of the nut meats were ejected in wholes or halves. Briefly, the nuts are fed between two belts over a slotter and a nozzle discharging an explosive gas (13). The gas-filled walnut is released by the belt and passes an igniter. The resultant explosion separates the meat and the shell. The capacity of the experimental machine was 900 lb per hr of unshelled walnuts.

TABLE 1 SCREENS USED IN SELECTING CARBON SAMPLES

Carbon size, no.	Passing through Tyler screen, mesh	Size of opening, in.	Retained on	Size of opening, in.
1	2	0.371	4-mesh hardware cloth	0.221
2	4	0.185	No. 11 round hole	0.170
3	8	0.093	No. 43 round hole	0.092
4	14	0.046	Tyler 28-mesh	0.023
5	28	0.023	Pan	0.000

Solar Heaters. As the supply of Nature's fuels decreases, greater use of solar radiation for heating and power conversion will result. The test results and appropriate technical data (14) on solar heaters are of utility in present-day design and also yield a glimpse into the future. Fig. 5 reveals experimental solar water heaters and Fig. 6 the useful heat output of the thin flat-tank absorber on clear days. In July, 15 gal of water could be drawn at 4:00 p.m. from an uncovered sloped cylindrical 30-gal tank above a temperature of 110 F with an ambient air temperature of 90 F. Enclosing the tank and providing a glass cover made it possible to draw 20 gal at 120 F under approximately the same conditions noted.

Abbott (15) reports that small 2 to 5-hp units may become profitable for power generation under favorable conditions. Solar heat may be employed for refrigeration and may conceiv-

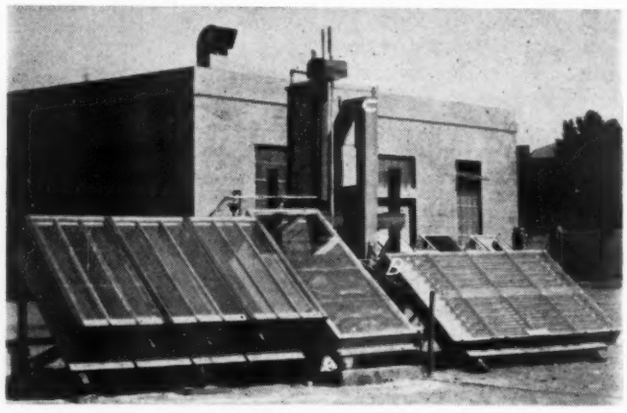


FIG. 5 THREE EXPERIMENTAL SOLAR WATER HEATERS AND ELEVATED STORAGE TANK

(At left an enclosed triple-tank heater is shown. Center heater is a thin flat-tank type, while the one on the right is a pipe-coil absorber, with a lower connection to the storage tank at *A*, and the upper connection at *B* through the insulated riser *C*.)

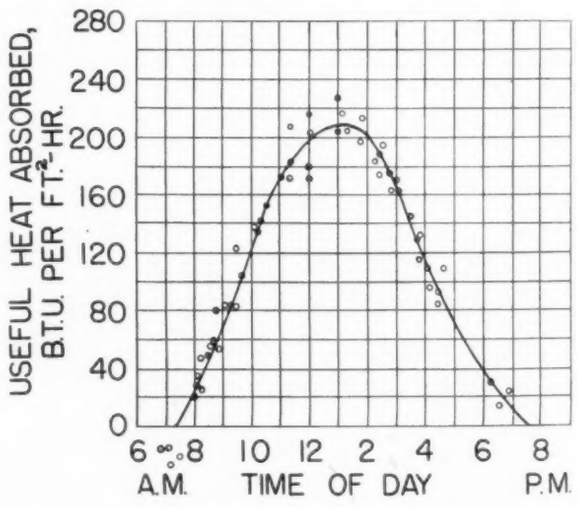
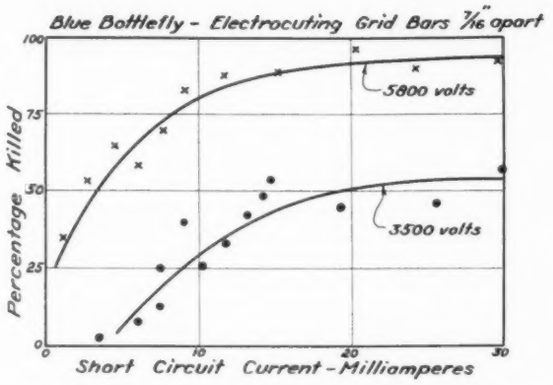
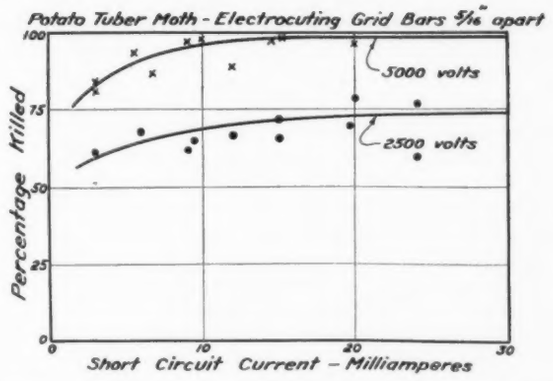


FIG. 6 USEFUL HEAT OUTPUT OF THIN FLAT-TANK ABSORBER ON CLEAR DAYS

(Davis, Calif., September 23–27, 1935.)



(Percentage bluebottle fly electrocuted by $^{7}/_{16}$-in. spaced grid bars at 3500 and 5800 v shown as function of short-circuit current.)


Potato Tuber Moth - Electrocuting Grid Bars 5/16" apart
Percentage Killed
5000 volts
2500 volts
Short Circuit Current - Milliamperes

(Percentage potato tuber moth electrocuted by $^{5}/_{16}$-in. spaced grid bars at 2500 and 5000 V plotted as function of short-circuit current.)

FIG. 7 TYPICAL CURVES SHOWING PERCENTAGES OF INSECTS KILLED AT DIFFERENT CURRENTS AND VOLTAGES

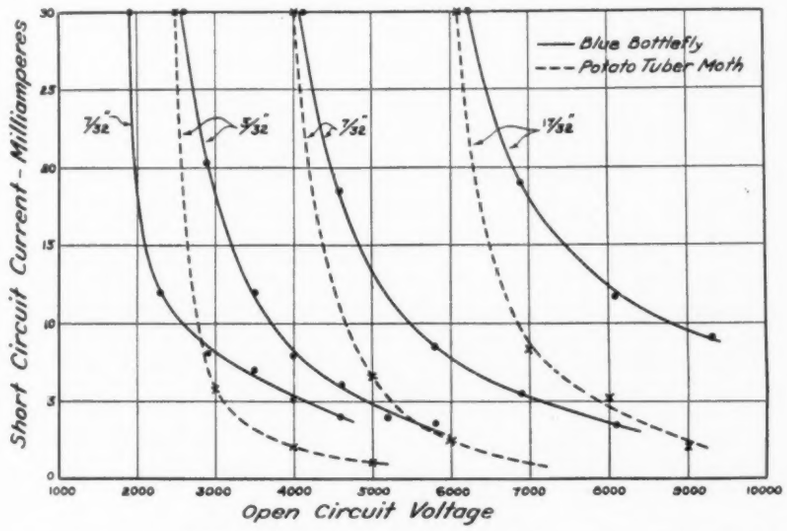


FIG. 8 CURRENT AND VOLTAGE NECESSARY TO OBTAIN A 75 PER CENT KILL OF INSECTS ON GRIDS VARIOUSLY SPACED

ably be utilized for air conditioning on ranches located in cloudless regions.

Insect Traps. Insect pests (16) are attracted to light of various colors. If, in traveling to the point of attraction, the insect passes grids which are electrically charged, destruction will result. Grid spacing depends upon the insect size. Grid voltages and the power supply must be adequate to burn or knock the insect from the grids. Figs. 7 and 8 indicate limits of design and operating conditions for two types of insect, the bluebottle fly and the potato tuber moth. Application of insect traps of this type in fields and around resorts has proved advantageous.

Two more illustrations, not chosen from the activities of the California Agricultural Experiment Station will be cited.

Hay Curing. Freshly cut alfalfa is superior in feeding value to any of the preserved hays prepared from it. Both field drying and artificial dehydration cause a loss of nutrients (17). Alfalfa initially contains 75 per cent moisture, which content, in the case of artificially dried special-purpose alfalfa, is often reduced to 5 per cent in order to facilitate grinding and separation.

American manufacturers have produced three types of driers:

1 Rotary-drum (entering gas temperature 1400 F)
2 Conveyer-belt (entering gas temperature 200 F to 500 F)
3 Pneumatic (entering gas temperature 1400 F).

In every case, gases of combustion of hydrocarbons (oil or coal) mixed with air are passed in either parallel or contraflow with respect to the raw hay. The gases are often broken into several separate parallel streams or may be directed through several passes. Construction features do not allow the hay to be in contact with hot gases sufficiently long to be scorched. The conveyer-type drier usually employs more tempering air than the drum type. In the pneumatic type, the hot gases are directed upward through the green hay which is fed directly into the gas stream. The particles containing the least moisture will rise to positions in the low-velocity and low-temperature regions of the gas stream. Similar effects are accomplished in some rotary driers. In the conveyer type a uniform green-hay mat is laid by a power-driven mechanism in an attempt to provide a uniform resistance to gas flow through the bed.

The marked saving in nutrients and the improved quality of the artificially cured hay recommend consideration of this method to large hay producers, especially for localities which experience uncertain summer weather. These nutrients are not necessarily conserved upon storage.

Electronic Sorting and Sizing. Color sorting of agricultural products (beans) (18) has been accomplished with success. A unit (say, one bean) is brought into position by pneumatic or mechanical means. The change in reflectance or the change in color will modulate the reflected light beam which in turn is

incident upon a photocell. A change in excitation of the photocell will operate a relay (through adequate amplifiers) and eliminate the defective unit from the line. A "standard" unit must be brought into position at intervals to account for drift in the circuit. Circuit adjustment may be manual or automatic. Units possessing regional color defects may be sorted by scanning them with a small pencil of light.

Sizing of units possessing one axis of symmetry may be readily accomplished, provided this axis may be oriented mechanically with respect to the light beam. The modulation of the transmitted light beam may be utilized to actuate solenoids opening gates to the proper distribution channels.

The solution of the mechanical problems, in connection with sorting and sizing, presents much more difficulty than the electronic circuit. Due to the low load factor, and other variables, electronic sorting may not be as economical as manual sorting. For instance, in manual sorting of a relatively uniform product, only a few units need be handled, while on the other hand the mechanical sorter must handle each unit.

GENERAL DISCUSSION

The foregoing brief description of some of the engineering problems being currently solved has been presented in order to show that the unit operations (1) of electrical and mechanical engineering are employed in the solution of such agricultural-engineering problems. H. B. Walker has divided the field of agricultural engineering into four major activities in accordance with the following classification:

1 Power and machinery
2 Structures
3 Rural electrification
4 Land conservation and reclamation, including irrigation.

In this paper only a few phases of two of the subdivisions have been presented. The solutions found for agricultural-engineering problems are often sufficiently general to be of use in other fields of engineering. The author finds the agricultural-engineering literature to be a valuable source of data.

Far too often the agricultural engineer finds, just as does the mechanical engineer, that basic properties of materials are not available. Also, he finds that the application of physical laws to some phenomena is somewhat obscure. For example, the information on earth irradiation by the atmosphere was certainly scanty and in some instances was misleading. He then determines the properties and clarifies the interpretation of the phenomenon.

The agricultural engineer often finds, upon completion of an investigation, that his findings confirm practice. This, too, is the experience of the mechanical engineer. We may then inquire into the general question of engineering investigation and research. Careful experimentation will usually lead to formulation of the results. Logically formulated results may be interpolated and extrapolated within the limits set by the original experimental system. Formulated results may be transmitted readily by teachers and in the literature. In this form, engineering knowledge may be transmitted by the teacher in the classroom as well as by foreman, artisan, or master. A conclusion may be drawn to the effect that the number of students in the technical schools will increase in fields of activity in which knowledge is being numerically and analytically formulated at a great rate. The slower specialized and less accurate methods of the transmission of knowledge are being superseded.

All agricultural-engineering solutions, in common with all other engineering problems, must be tested on a cost basis. A development will not be accepted unless it is economically sound. The results of the investigation must not only be formulated (as noted) but must also be interpreted for the farmer.

In this paper the problems of developing industrial uses for agricultural products (19) have not been mentioned. The author has attempted to indicate that the tasks of the agricultural engineer (restricted to production, raw processing and transportation) require the incidence of knowledge from all of the fields of engineering as well as from the "life sciences." Finally, the problems which the agricultural engineer is engaged in solving are intriguing and stimulating. The solutions usually include basic data which may be utilized in other fields. The author, who has served in this paper only as an interpreter of the activities of the agricultural engineer, wishes to thank Prof. H. B. Walker, Division of Agricultural Engineering, University of California, Davis, Calif.; for his guidance and encouragement.

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The DESIGN *of* EXPERIMENTS

By H. A. FREEMAN

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DR. FISHER'S book[2] considers, in the main, the relationship of statistical principles to the design and analysis of agricultural experiments. Although it is difficult to say to what extent Dr. Fisher's more complex designs will find a place in engineering investigations, the contents of his book should be of interest to all who are concerned with scientific experimentation. Furthermore, many of his designs have obvious immediate engineering possibilities.

The first chapter is introductory; the second considers the case of a lady who believes that she can judge whether the tea she drinks has had milk or tea added first. The author discusses various experiments which might be employed to test the lady's ability. He brings out the relative adequacy of very small samples of information—if the lady is willing to be tested on an infallible-or-not basis—and he shows the superiority (and necessity) of larger experiments if occasional error in selection is to be permitted. The advantages and disadvantages of an experiment in which the subject knows that half of the cups have had tea added first are compared with those of the statistically superior but possibly unfair test in which the subject's cups are selected entirely at random. None of this requires more than elementary probability theory but the point of view—the use of statistical principles in the planning stage of an experiment rather than only at its conclusion—may be novel to some readers. In addition to this, industrial laboratory workers who must carry out experiments in which the variable under investigation can take on only two values (as when "go no-go" gages are used) will especially benefit from Dr. Fisher's clear exposition of some of the statistical issues involved.

"REARRANGEMENT" OF DATA AND THE IMPORTANCE OF RANDOMIZATION

In the third chapter, Dr. Fisher points out, first, the serious error which may result from "rearrangement" of data and second, the importance of randomization. He deals with the case in which Charles Darwin, having carried out an important series of experiments which appeared to show the superiority (in height) of cross-fertilized over self-fertilized plants, sent the data to the English statistician Galton for more exact analysis. Instead of analyzing the differences in heights of pairs of self- and cross-fertilized plants grown in the same pot (as Darwin had grown them) Galton rearranged both series in order of magnitude, irrespective of pots, and studied the resulting artificially paired differences.

Dr. Fisher uses this example of improper analysis to illustrate two principles (1) that rearrangement of data cannot increase the amount of information to be obtained and (2) that rearrangement of the kind mentioned loses for us the advantages of controls (the relative uniformity of "other conditions" within any one pot as contrasted with more likely heterogeneity, such as differences in soil structure, from pot to pot). The following data, which are both hypothetical and abbreviated, illustrate these points.

	Amount of corrosion		
Soil	Pipe X	Pipe Y	Difference
A	12	10	2
B	17	14	3
C	16	19	−3
D	20	18	2

Any rearrangement of these data would be unwise. We wish to discover whether pipe *X* or *Y* is more susceptible to corrosion and in the process of design and analysis we want, as far as possible, to eliminate the effects of all other variables such as, for example, differences in the corrosion rate of (any kind of) pipe due to different soils. As the data stand, the quantities 2, 3, −3, and 2 are unaffected by soil differences (which evidently exist, for soil *D* is the hardest on pipe while soil *A* is easiest) whereas no such guarantee can be given if these controls are removed by rearrangement.

Darwin apparently made no effort to randomize the positions of his plants in each pot. Possibly the cross-fertilized plants always had preferred positions with respect to sunlight or some other important factor; any statement as to the superiority of cross-fertilized plants is, therefore, possibly open to question. Similarly, pipe must be laid in a random way with respect to factors (other than those studied) which could influence corrosion. It might be thought that systematic arrangements are superior, that is, that we might place cross-fertilized plants on, say, the right side in the first pot, on the left in the second, on the right in the third, and so on. This question is still far from settled but it is a fact that most of the statistical tests which we are accustomed to apply to data are vitiated by systematic arrangements. The actual error incurred by such application may be slight and the real gain made by such arrangements may be considerable; furthermore, modified tests applicable to systematic schemes are to some extent already available. But we will have to leave this debated question alone.

The chapter closes with a valuable numerical illustration of the fact that the usual test for the significance of the difference of the means of two small samples is not greatly affected by lack of normality (the principal assumption) in the populations of which the two samples constitute random drawings.

ILLUSTRATING USES OF LATIN SQUARES

The fourth chapter introduces restricted randomization in the form of Latin squares. Instead of illustrating the uses of these squares by citing Dr. Fisher's data from agricultural experiments, consider an industrial example for the work of Tippett.[3]

An experiment is required which will indicate whether or not the effects of four treatments *A*, *B*, *C*, and *D* on a quality

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "The Design of Experiments," by R. A. Fisher, Oliver & Boyd, Edinburgh, Scotland.

[3] "Proceedings of the Engineering and Industrial Statistics Conference" held at M.I.T., Isaac Pitman & Sons, New York, 1939.

characteristic of yarn are statistically significantly different. If loom differences are removed by spinning all the yarn on one loom, many periods (weeks) will be necessary in order to complete the experiment. Furthermore, time differences enter. If we control time effects by using many looms, considerable disruption of plant routine may result and loom differences, in which we are not interested, will mount up. In such a case, a Latin square design is useful; it compromises on the amount of time and the number of looms that will be needed but, of paramount importance, it permits efficient elimination of any primary effects on yarn quality which these two factors may exert.

		Looms			
		1	2	3	4
Periods	1	*A*	*C*	*D*	*B*
	2	*D*	*B*	*C*	*A*
	3	*C*	*A*	*B*	*D*
	4	*B*	*D*	*A*	*C*

The elimination of loom and time effects is seen to be valid because each treatment is represented an equal number of times (once) for each loom and for each period. Furthermore, if subject to this double restriction the treatments are assigned *at random*, the effects of treatments can be judged significantly different or not by use of the method of analysis of variance described in modern textbooks on statistics. Once again, systematic allocation of treatments may really be superior to random allocation but, as already noted, the customary test (in this case, the z-test) is no longer applicable.

A Latin square clearly improves the precision of the experiment, for the error against which we compare differences in treatment effects is reduced by the exclusion of loom and period effects. The example given utilized one of the simplest types of square designs; many more complex experimental arrangements have found uses in agricultural research and a few have already been introduced into the research technique of engineering and industrial laboratories.

FACTORIAL DESIGN

The fifth chapter brings us to a method which may not be a familiar one to engineers, namely, factorial design. Assume that we are interested in investigating reasons for variability in the strength of bolts, and, to take a simple example, the bolts in question may be produced (*a*) on one of two machines, (*b*) with one of two percentages of carbon, (*c*) under the supervision of one of two operators. In order to discover the degree to which each of the three factors is responsible for the variable quality, the experimenter would probably control two of the three factors (for instance, use bolts all of which were produced on one machine and by one operator) and vary the third (the percentage of carbon). This would have to be done three times in order to determine the influence of each factor.

As an alternative method which has certain advantages over that just described, Dr. Fisher suggests a factorial design. We would make eight observations as follows:

QUALITY OF BOLTS

1	2	3	4	5	6	7	8
Machine	Machine	Machine	Machine	Machine	Machine	Machine	Machine
A	*α*	*A*	*α*	*A*	*α*	*A*	*α*
Operator	Operator	Operator	Operator	Operator	Operator	Operator	Operator
B	*B*	*β*	*β*	*B*	*B*	*β*	*β*
Carbon %	Carbon %	Carbon %	Carbon %	Carbon %	Carbon %	Carbon %	Carbon %
C	*C*	*C*	*C*	*γ*	*γ*	*γ*	*γ*

This experiment may have to be repeated and, secondly, each of the foregoing eight blocks may represent more than one bolt. But this is incidental. The main point is that from such data we can determine not only the effects on quality of each factor taken alone but also the effects of pairs of causes and the interaction of all three causes. Operators may work particularly well on certain machines; such information is automatically furnished by our experiment, in addition of course to information on the subject we set out to investigate. It is worth noticing that such interaction effects are lost in experiments of the hold-all-but-one-factor-constant type.

FACTORIAL DESIGN NOT ALWAYS DESIRABLE

It does not follow that factorial design is always desirable. On the contrary, when control is easily effected as in experimental physics, it is probably wise to use control and lose information on interactions. But in biology, engineering agriculture, and the social studies where other factors are not easily controlled and where interactions have real meaning, factorial design is useful. Furthermore, a considerable economy in sample size is accomplished by the use of such designs, for *each* experiment yields information on *all* factor effects. Thus, if in the example cited, we take

Block 1 minus block 2
Block 3 minus block 4
Block 5 minus block 6
Block 7 minus block 8

we obtain four quantities each of which is an unbiased index of the effect of machines, for in each quantity "carbon %" and "operator" remained constant. And from the *same* data, we have

Block 1 minus block 3
Block 2 minus block 4
Block 5 minus block 7
Block 6 minus block 8

which yield four unbiased estimates of the effect of operators on quality. Finally

Block 1 minus block 5
Block 2 minus block 6
Block 3 minus block 7
Block 4 minus block 8

show the effect of carbon on quality. The actual technique of analysis is not that given here but the foregoing illustrates the economy of factorial design.

REMAINDER OF BOOK DEALS WITH MODIFICATIONS OF METHODS ALREADY DESCRIBED

The remainder of Dr. Fisher's book is concerned with modifications of some of the methods already described. In particular, he discusses special types of factorial designs which permit an increase in the accuracy of our estimates of the effects of single factors at the expense of some loss of information on a few or all the interaction effects.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Day by Day

IT IS a relief to turn from domestic and international dissensions to pay tribute to men, living and dead, who have served engineering and their fellow men in the productive pursuits of peace. In the deepening twilight of civilization that is spreading so ominously from Europe, the lives and achievements of these men stand out like stars in the firmament of human history to proclaim the eternal sources of light that are a guide in darkness and a promise of dawn. If one is tempted to lose faith in man he would do well to consider men. Man may appear to progress or to falter, but every age produces men it can afford to honor.

Hoover Medal

In amelioration of the afflictions of war and other widespread disasters, no man of our time has labored more effectively or with greater success in the constructive application of the engineer's method than has Herbert Hoover, honorary member A.S.M.E. To commemorate his services, at present being extended in organizing relief for Finland, Conrad N. Lauer, past-president A.S.M.E., provided the Hoover Medal, which is awarded by the four Founder Societies "to a fellow engineer for distinguished public service."

At the winter convention of the American Institute of Electrical Engineers in January, 1940, the Hoover Medal was awarded to Gano Dunn, of New York, whose name was thereby added to those of Herbert Hoover, Ambrose Swasey, and John F. Stevens, the only other recipients to date.

It was appropriate that Gano Dunn, upon receiving this high award for distinguished public service, should clarify what the term means and differentiate between service rendered to the public by government and by all private activity, for which economic compensation is received, and that which is rendered by men and women over and beyond that for which they are paid, "a service they render on account of love for their fellow men, and the satisfactions that come from doing something well, for the love of doing it rather than for the pecuniary reward it brings."

Of both of these types of public service Mr. Dunn has rendered full measure, on the one hand, as head of one of the world's great engineering firms whose achievements have been numerous, widespread, and noteworthy, on the other, in benefits, beyond those recognized by pecuniary reward, to his fellow engineers and the engineering profession, to education, and to the community and the nation. To one who, like Mr. Dunn, met the handicap of a sudden and unexpected interruption of his education by assuming the expense himself through his earnings as a telegraph operator, the successful career and the esteem of the public he now enjoys are the rewards of merit and hard work. His part in the development of the Engineering Societies Library and in that great forward step in the unification, in this country, of the engineering profession that took the substantial form of the Engineering Societies Building in New York will long be remembered as an early indication of the quality of public service that has won for him the award of the Hoover Medal.

A variety of talents and broad interests has marked him as a man to be called upon by his fellows to undertake tasks of service and leadership in international gatherings of engineers, in the stimulation and organization of research, and in appointments by the President of the United States where his wisdom and judgment have been needed. To the popular conception of the engineer as a narrow technician he provides a conspicuous contradiction. He ably disproved the cynical aphorism that the higher an engineer moves in executive positions the lower falls his I. Q. at a recent gathering of distinguished men by an extemporaneous but masterly description of nuclear disintegration and its possible engineering significance, a feat which even an expert in the field might easily have bungled.

Edison Medal

To Philip Torchio, on the night on which the Hoover Medal was presented to Gano Dunn, was awarded the Edison Medal of the American Institute of Electrical Engineers "for distinguished contributions to the art of central-station engineering and for achievement in the production, distribution, and utilization of electrical engineering."

Native of Italy who came to this country in 1893 to work with the Sprague Electric Elevator Company and who has been employed from 1895 to his retirement in 1938 by the New York Edison Company and its successor, the Consolidated Edison Company of New York, Inc., Mr. Torchio rose to the position of chief engineer of that company in 1905 and to that of vice-president in 1924. His contributions have been those of a pioneer in the rapidly developing electric-utility industry. The period of his services covered the years in which decisions affecting the future of the industry, such, for example, as the choice of frequency for alternating-current distribution, had to be made. He made them for his company. He early sensed the importance of the economic phases of the electrical problems he was forced to solve and initiated many of today's practices. A long list of patents and technical papers attests the fertility of his mind.

Dow

The news of the month was enlivened by the unexpected retirement from the presidency of The Detroit Edison Company of Alex Dow, past-president A.S.M.E. Few of the vigorous race of pioneers in the electric-utility industry have overstayed Mr. Dow in active administrative responsibilities and few have earned as completely as he the respect of colleagues and the public. Strong qualities in his Scotch heredity have empha-

sized the marked individualism for which he is known—an individualism which in former days would have been termed rugged without implied reproach.

It is well known to engineers that Mr. Dow's individualism extends, to his credit, to his organization and undertakings. To his credit also it may be said of Mr. Dow that had all utility executives shared his sound methods of conducting public relations and corporate enterprises, the industry would be in higher favor and less harassed than it is today. This is no mean tribute to any man in public service and redounds to the prestige of the engineering profession.

Mr. Dow is one of those persons to whom human interest is inevitably attached. One suspects that among many who have come even slightly under his influence his deeds and words will become legendary. His abilities as a storyteller and at turning an apt phrase fix him indelibly in the memory. Who, for example, can forget the night he stood beside Henry Ford at an A.S.M.E. dinner in Detroit and presented to this lifelong friend and former associate the Holley medal? Who will forget the white four-in-hand tie? "Haven't changed the style of my business dress in 30 years," he is said to have remarked. "Guess it's the engineer in me—I've got to standardize everything." One of America's wise men, perhaps the Scotch word "canny" fits him best.

Atom Smashers

Not in many a day has so fascinating a demonstration lecture held an audience spellbound in the Auditorium of the Engineering Societies Building as that cooperative effort of Enrico Fermi, Nobel prize winner in physics in 1938, and John R. Dunning, professor of physics at Columbia University, on the subject of atomic disintegration. Readers of MECHANICAL ENGINEERING were given the text of Dr. Fermi's lecture in last month's issue, but this text could not be accompanied by the demonstrations so successfully conducted on the platform by Professor Dunning, nor was it closely followed in Dr. Fermi's oral presentation.

The technique of the demonstration lecture was so perfect that it deserves comment. Dr. Fermi took the rostrum first and in clear simple language, without reference to manuscript or notes, described the developments in atomic physics up to the death of Lord Rutherford when it had been shown that bombardment of the nucleus would result in transmutation of elements into others of closely equivalent atomic number. Professor Dunning next gave some demonstrations of these transmutations, turning silver into cadmium and platinum into gold (in submicroscopic quantities to be sure) with the release of energy.

Returning to the lecture, Dr. Fermi then told of the startling discoveries of the last year in which the bombardment of the uranium nucleus resulted in a fission in which two particles of barium were formed with the release of relatively much greater amounts of energy and the possibility that a chain reaction might be set up which, if properly controlled might provide a commercial source of energy, a fifty-fifty chance at present. Further demonstrations by Professor Dunning were carried on with the bombardment of the uranium nucleus.

The intense intellectual excitement that was stimulated by the exposition and demonstration of these pioneer efforts at truly scientific transmutation and of conversion of matter into energy was apparent in the attitude and attention of the audience. Each one sensed, perhaps, that he was present at an epoch-making occasion, and that the future held in store marvels that would eclipse the blight of war and the twilight, in some parts of the world, of science and human progress.

Science Writers

In an age when science advances rapidly it becomes necessary to interpret its progress to the public in language that can be understood. This is no easy task, as anyone who has tried to do it can testify, and hence it is proper to applaud men who labor at this task through the daily papers. Two of these writers have recently been recognized in public, Harold W. Blakeslee, general science editor of the Associated Press, who received the Wilson L. Fairbanks award of the College Publicity Association, and William L. Laurence, who was honored recently at a dinner of the American Institute. Both Mr. Blakeslee and Mr. Laurence have reported A.S.M.E. papers and meetings and have worked in close cooperation with the Society in bringing the news of engineering into public notice. Public recognition of men working in this important field of education and journalism is long overdue.

Mead

One of the significant sessions of the winter convention of the American Society of Civil Engineers held in January was conducted under the auspices of student members of that society and was addressed by its past-president and honorary member, Daniel W. Mead. Professor Mead's contributions to engineering practice and education are well known, and unique among them have been his efforts to improve standards of professional relations and conduct and to give engineering students an insight into this important but nontechnical branch of their training.

Perhaps the greatest authority that attaches to whatever Professor Mead may write or say on this subject springs from the broad experiences of the man himself and the high integrity of his character. His is no theoretical or academic approach to the subject but an intensely practical one. Common honesty and decent considerate behavior are not unique with the engineering profession, but the code that governs approved practices in professional relations and conduct is not always obvious to the inexperienced and may sometimes be unconsciously violated, through ignorance and innocence, by sincere and honest men. Professor Mead's paper on the subject, prepared at the request of the Board of Direction of the American Society of Civil Engineers, will be found in the January, 1940, issue of the *Proceedings* of that society.

Vauclain

On February 4, Samuel M. Vauclain, honorary member A.S.M.E. and chairman of the board of the Baldwin Locomotive Works, Philadelphia, died at the age of 83. In his death there passed a stalwart figure in the engineering and manufacturing world, a man of vigor and energy whose name will always be associated with the history of the locomotive.

Mr. Vauclain was born into an era of industrial expansion and an environment that demanded hard work. He was typical of those who increase the world's wealth by improvements in production methods. His first lesson in this useful accomplishment was in shelling corn, which he learned could be done more easily and rapidly by pulling the ear over the edge of a spade fixed over a washtub. All his life, he once said, he had shelled corn. All his life advancement came to him because he learned how to produce more.

He was apprenticed as a machinist at 16 in the shops of the Pennsylvania Railroad and almost immediately organized a job of turning some bolts with a success that amazed his foreman.

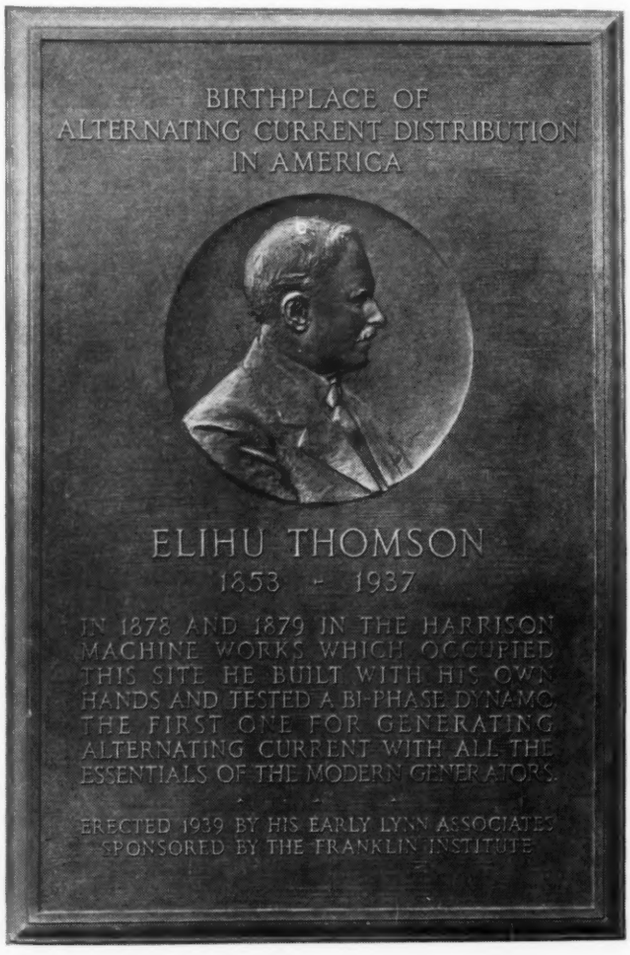
Promotion followed, and soon he took the place of the "Big Boss" of a gang of 60 men. "I went to work, brought order out of chaos, put every man in his place (don't ask me how, but I weighed one hundred and eighty pounds, was six feet tall, no fat but plenty of brawn)." He was married on $8.40 a week and started to build a house with a capital of $25.

In 1882 he went to Philadelphia to supervise for the railroad an order for 60 locomotives at the Baldwin Locomotive Works. In 1883 he entered the employ of Baldwin's and introduced there his methods of "shelling corn." Under the pressure of his energetic methods the works grew and in one year produced as many as 3580 locomotives.

As a raconteur Mr. Vauclain delighted his friends with amusing and characteristic anecdotes of his full and varied career. One recalls the story of the famous compound locomotive and the rack locomotive for Pikes Peak, with the hope that these and many others are preserved somewhere. Here was a man who was typical of the age he helped to create, perhaps the most exciting age of industrial history in the United States.

Thomson

On January 3 a tablet, in honor of Elihu Thomson, honorary member A.S.M.E., shown in the accompanying illustration, was unveiled by Mrs. Thomson. It was erected on the Middle City Building, Ludlow Street, Philadelphia, site of the shop where Professor Thomson built the first biphase dynamo.


BIRTHPLACE OF
ALTERNATING CURRENT DISTRIBUTION
IN AMERICA
ELIHU THOMSON
1853 - 1937
IN 1878 AND 1879 IN THE HARRISON
MACHINE WORKS WHICH OCCUPIED
THIS SITE HE BUILT WITH HIS OWN
HANDS AND TESTED A BI-PHASE DYNAMO
THE FIRST ONE FOR GENERATING
ALTERNATING CURRENT WITH ALL THE
ESSENTIALS OF THE MODERN GENERATORS
ERECTED 1939 BY HIS EARLY LYNN ASSOCIATES
SPONSORED BY THE FRANKLIN INSTITUTE

TABLET TO ELIHU THOMSON UNVEILED AT PHILADELPHIA

Plastic From Sawdust

U. S. FOREST PRODUCTS LABORATORY

MOLDING plastic from waste wood has been produced by chemists of the United States Forest Products Laboratory, Madison, Wis., at a cost of about 3 to 4 cents per lb, about one quarter the price of plastics in use today. Practically unlimited sawdust and hog waste are available for raw material. Thus far, hardwood waste has been used to best advantage; softwood waste requires some modification of the process.

The process consists in breaking down the mortar-like bond between lignin and cellulose, which makes wood stiff, by converting some of the woody material into sugar which is washed out and can be fermented into alcohols or used in green silage. To the remaining mass of material there is added 10 to 15 per cent of an inexpensive plasticizer, and then the batch is ground to the fineness of flour and used as a molding powder. Properly heated under pressure, the lignin plastic takes the shape of the mold and produces a black, lustrous, dense substance which can be easily sawed, turned, or otherwise machined. The resultant material has adequate tensile and compressive strengths for most uses, is an excellent electrical insulator, and absorbs little water.

One limit is its single color, black; but its surface can be modified by pressing in foil, veneer, or metallic powder, and it takes paint well. Because it flows none too rapidly and needs to cool about 20 F below the pressing temperature of 300 F in the mold, it takes a little more time in the mold than other plastics. One promising field for its use is in composition with metals. The lignin plastic bonds to metal surprisingly well, stands up to stiff tests, such as turning without chipping on the outside circumference of a cylinder laminated of alternate layers of plastic and metal. Experiments are being carried on in Detroit for possible use in trunks, fenders, and other large exterior automotive parts.

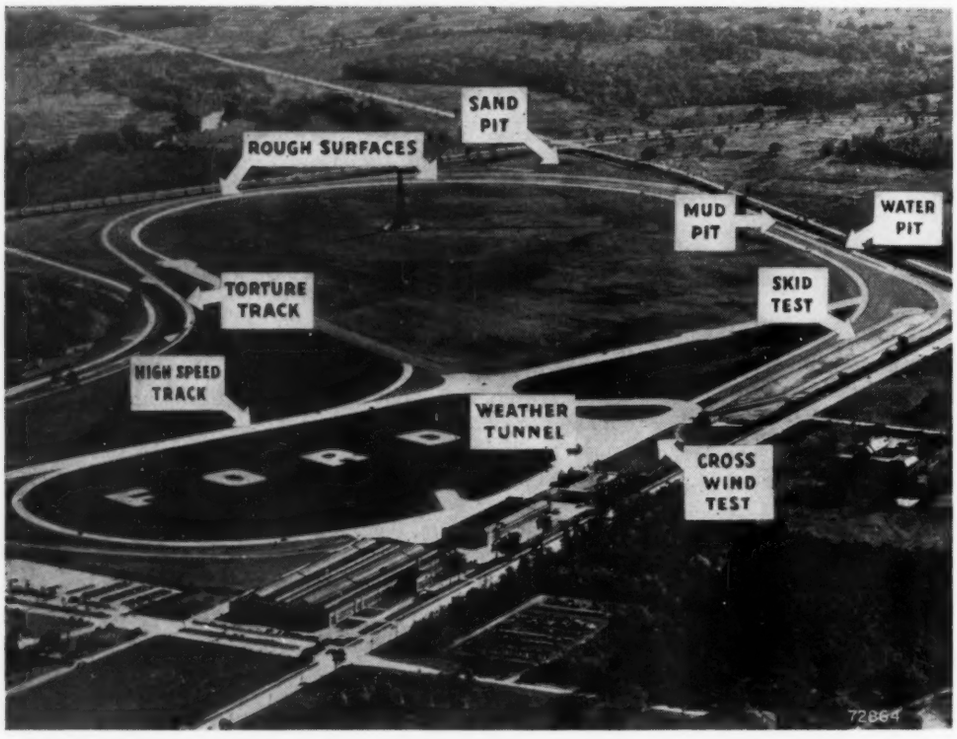
Plastics in Transportation

VARIOUS SOURCES

PLASTICS are being used in increasing quantities in all fields of industry, particularly in transportation. In this latter field, plastics may be used as molding materials to produce various parts and accessories or as coating compositions, such as varnishes, dopes, and adhesives. Molding materials may be applied in four different ways: Compression molding, injection molding, extrusion, and lamination. The last-mentioned method is really a specialized application of compression molding. Then there is the acrylic type of plastic which can be cast and pieces of desired design obtained by cutting, turning, and polishing. For a comprehensive outline of the different methods used in the production of plastics, the reader is referred to a paper on the subject, presented by Dr. G. M. Kline at the annual meeting of the S.A.E., Detroit, Mich., Jan. 15–19, 1940.

PLASTICS IN THE AIRPLANE

As materials of construction in the airplane, plastics are interesting to the aeronautical engineer on account of their relatively low specific gravity, compared with metals and glass. The specific gravity of any plastic lies between just over 1.0 and 1.6. Tensile strength varies with the type and grade of material, but figures up to 7000 lb or 8000 lb per sq in. are not uncommon.



AIR VIEW OF AN OUTDOOR LABORATORY

(Shown here are the test tracks of the Ford Motor Company in Dearborn, Mich., where virtually every factor in motorcar design and performance may be tested under rigidly controlled conditions. The weather tunnel permits the engineers to test new car designs in almost every kind of adverse weather conditions, such as sleet or dust storms, hurricanes, blizzards, and tropical rainstorms. The water pit is 300 ft long and the mud pit is 200 ft. They are used to test the effect of mud and water on the springs, torsion bar, steering mechanism, brakes, and body. The skid test section is used to test tire traction and other safety factors on wet roads, and to assist in developing better tire treads. The sand pit and the "wobble" track or "body twist" section help the test engineers to ferret out any possible construction weakness in new cars. Particularly interesting is the huge wind machine which develops cross winds with a top velocity of 50 mph.)

According to an article in *The Aeroplane* (London), Dec. 8, 1939, one of the first applications of plastics which meets the eye is the center covering of the cockpit, or at least the windows of the cabin. Weight alone is against the use of safety glass for this purpose. The materials used are mainly cellulose acetate and acrylic plastics. Both types can be produced almost colorless and transparent; both can be shaped into curved sheets, if required; and both possess noninflammable qualities and good strength. The acrylic plastics have the added advantage of retaining their transparency even in thick sheets.

Laminated materials based on phenolformaldehyde plastics are used in the production of propellers, gearing, and bearings, because of good mechanical strength and resistance to abrasion and warping. Laminated sheet based on ureaformaldehyde can be produced in more artistic colors than that based on phenolformaldehyde. Consequently, this type of sheet finds considerable utilization in decorative paneling for interiors of cabins, and similar uses, in air liners.

Still on the construction side, phenolformaldehyde and ureaformaldehyde resins, especially the former, find application as adhesives in building up various parts, particularly where wood has to be joined to wood or to laminated material or metal. Casein adhesives are also used sometimes, but these are not quite so resistant under tropical conditions and where fungoid growth may be encountered. Wooden blades for propellers are frequently protected nowadays against splintering by covering them with a sheathing of cellulose acetate. Cellulose-acetate or cellulose-nitrate dope or varnish is used for coating fuselage parts. The former is gaining ground at the present time because of its noninflammable qualities compared with the cellulose-nitrate dope or varnish used on some airplanes today.

In addition to the foregoing constructional applications, plastics find outlet in various electrical and other accessories found in airplanes. Most of the "glasses" of instrument dials are now made either of cellulose acetate or acrylic plastics. They are lighter than glass and do not break so readily through vibration or shock. Turning to the instruments themselves and to instrument panels, these are frequently molded from phenolformaldehyde materials. Some wires and cables are insulated by sheathing them with a plastic varnish or with rubber, but recently there has been much development in the use of extruded vinyl plastics for this purpose.

The writer makes the prediction, based on the present tendency of the plastics industry in general, that parts and accessories of larger dimensions will be made from plastics. Incidentally, a "plastics" airplane was described in this section in the July, 1939, issue of MECHANICAL ENGINEERING.

PLASTICS IN THE AUTOMOBILE

All types of plastics are used in the modern automobile, from the timing gears to the decorative trim on the body. According to an article by William T. Cruse, appearing in *Modern Plastics*, January, 1940, the Ford Motor Company has molded experimentally in a 1200-ton press trunk-compartment doors for the Mercury car. The material for this and other plastic products are obtained from the soybean.

The plastics operations at the Ford plant devolve into two broad types of molding—conventional or compression, and injection. The molding material for compression molding is largely manufactured in the plant at Dearborn. It is known as soybean plastic. By a relatively simple solvent extraction process, oils are extracted from the soybeans leaving a protein meal. With the addition to this of phenol and formaldehyde, a protein-phenolformaldehyde product results. There is then added to this, zinc stearate and stearic acid to serve as mold lubricants and pigments for color. The chemists in the plant are now exploring the synthetic-textile possibilities of soybean derivatives. Pilot production quantities of yarn have been processed.

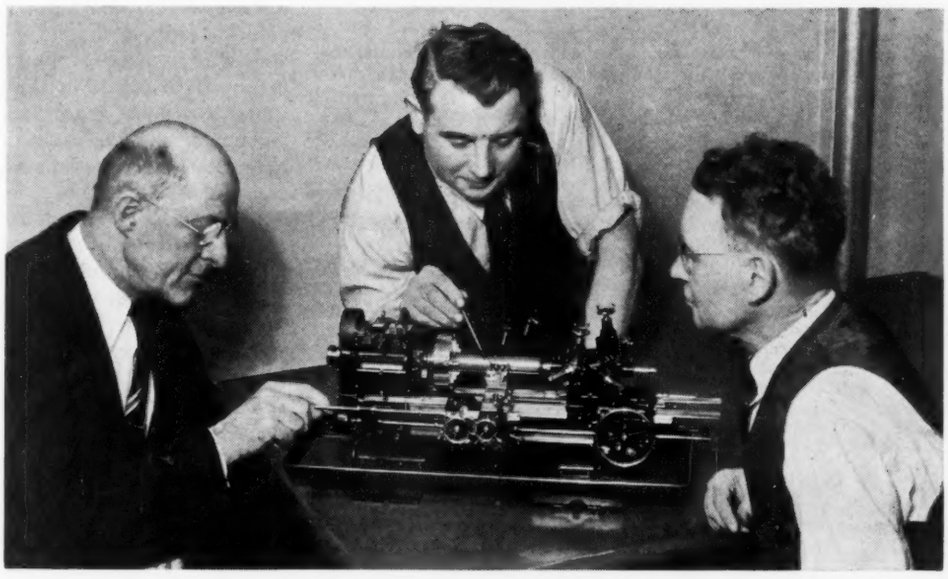
The soybean compound is molded into a variety of parts for use in the automobile, such as distributors, coil cases, and accelerator pedals. Ford tractors also have benefited through a newly designed plastic seat. Here a difficult molding problem involving a long draw was solved by using a papier maché

contour impregnated with bonding material.

Injection molding at the Ford factory is of more recent date; the types of parts thereby produced differ from those compression-molded, in that they are principally used for car interiors. Here, not only utility but color also is a desirable characteristic. For these reasons thermoplastic cellulosic plastic powders have been used. The soybean types, being thermosetting and lacking flexible color range, are not suited for such purposes.

Injection molding from cellulose acetate is used for the production of instrument panels, knobs, escutcheons, electric-lamp shades, horn buttons, and radio grilles. Departing from either compression or injection technique, the company has inaugurated and is using in the 1940 Zephyrs a decorative interior plastic-trim strip made by the extrusion or stuffing method. Cellulosic materials are extruded or stuffed by screw stuffers into continuous-length profile rods. These are cut to suitable length and each piece is then affixed to a steel back to make attractive trimming.

The author concludes by saying that with experimental garnish moldings meeting laboratory standard conditions, with trunk doors doing well in field tests, with tractor seats in standard production, with other exterior applications being proved, dreams of entire bodies from plastics approach nearer to reality.



A MINIATURE TURRET LATHE

(An exact replica in every detail of a full-size machine, including turrets that actually index, a headstock with a complete range of adjustable speeds, and a miniature oil pump that actually circulates coolant liquid, stole the show when employees exhibited their hobbies at the Warner & Swasey open house last week. The work of Paul H. Klamm, a planer-department foreman who has been building models as a hobby for several years, the miniature lathe is complete in every detail. It has way covers, a square turret lock bolt with remote control, rapid traverse, adjustable turning heads on the hexagon turret, even a tiny stop roll with adjustable stop screws—and everything works. Not much more than 20 in. in over-all length, the machine has gears in the apron feeds as small as 1/4 in. in diameter. Spurred by the remembrance of some very unusual models exhibited by his fellow employees at the company's open house last year, Klamm averaged 4 hours a day at his self-appointed hobby assignment for some 300 days. Klamm is pictured center above, showing the model to Wm. J. Burger, Warner & Swasey works manager (left), and Nels Swenson, plant superintendent.)

Lead and Silver in Steel

VARIOUS SOURCES

PRODUCTION of steels containing lead or silver has been started on a commercial scale by several companies in the United States during the last year. Some of these steels are already being used with success by machine shops and others. Because of the interest evinced by mechanical engineers in the development, properties, and uses of lead-bearing and silver-bearing steels, the current literature available has been investigated and the following brief article prepared from material obtained from various technical periodicals.

LEADED STEELS

Recent articles in *Metals and Alloys*, March and April, 1939, and January, 1940; *Iron Age*, Nov. 17, 1938; and *The Metallurgist* (London), August, 1939, have indicated that the addition of small amounts of lead to several open-hearth steels resulted in improved machinability without materially affecting the other physical properties of the steel. In view of the fact that lead is generally agreed to be almost, if not quite, insoluble in liquid and solid iron, and must therefore be liquid over a wide range of temperatures of working and treatment, these results are surprising. It is true that if the lead is allowed to segregate into microscopically distinct drops, which it may do if the amount added exceeds 0.5 per cent, cracking is experienced during rolling and the mechanical properties deteriorate. In lead-bearing steels, however, containing 0.25 per cent of lead, no globules are visible under the microscope.

The effect of lead on machining is additive to that of sulphur, but the properties of the high-sulphur, free-cutting steels are not affected in other respects by lead. In speculations on the mechanism of the improvement in machinability brought about by lead, all the usual factors seem to be ruled out. As engineers know, machinability can be improved by spheroidizing the carbide, by coarsening the grain, by adding to the phosphorus or nitrogen content of the ferrite and so increasing its brittleness, by introducing nonmetallic inclusions like sulphides, and by alloying additions which increase the rate of work hardening and so embrittle the chip. The effect of lead seems to fall into none of the foregoing categories, and yet may be additive to the effects of any of these factors. Chips coming from the lead-bearing mild steels are observed to be at a lower temperature than those from lead-free mild steels machined under similar conditions. The former show a yellow temper color when the latter are blue. This has suggested that the effect may be in the nature of lubrication produced by submicroscopic particles of lead.

In studies carried out on the properties and machinability of lead-bearing steel at the University of Illinois, T. J. Dolan and B. R. Price obtained the results shown in Table 1. Finally, the authors state that judging from the mechanical properties as obtained from the laboratory tests, the technical worth of the leaded steel probably would be about the same as that of the

TABLE 1 RESULTS OF MACHINABILITY TESTS ON LEADED AND OTHER STEELS

(Relationship between power requirements for drilling 1/4 in. hole, and the hardness, grain size, and ultimate strength of steel.)

Material	Brinell Hardness	ASTM Grain Size	Ultimate Strength, lbs. per sq. in.	Horse Power Required: at 90 surface ft. per min.	Horse Power Required: at 60 surface ft. per min.
Leaded steel, cold-drawn	211	5–6	115,000	0.551	0.372
Leaded steel, quenched-and-tempered	248	8	127,000	0.615	0.390
Leaded steel, normalized	168	8	96,000	0.527	0.428
Leaded steel, air-cooled after 2 hrs. at 2200 deg. F.	194	2–3	.....	0.502	0.431
Leaded steel, furnace-cooled after 2 hrs. at 2200 deg. F.	149	2–3	.....	0.525	0.420
0.49% C steel, normalized, quenched-and-tempered	180	1–3	94,300	0.700	0.456
0.49% C steel, normalized	164	6–8	91,500	0.835	0.527
S.A.E. 3140, hot-rolled	235	6–8	127,000	0.789	0.452
S.A.E. 2345, air-cooled after 2 hrs. at 2200 deg. F.	207	—1	114,000	0.623	0.537
S.A.E. 2345, furnace-cooled after 2 hrs. at 2200 deg. F.	207	—1	114,000	0.640	0.514
S.A.E. 2345, furnace-cooled from 1450 deg. F. after normalizing	212	7	110,000	....*	0.506
High-test cast iron	231	...	54,800	0.437	0.398
Gray cast iron	139	...	20,500	0.297	0.287
S.A.E. X 1112	141	8	72,500	0.537	0.360

* Would not drill.

same steel without the lead addition except for the item of machinability. Economically, the leaded steel is more expensive in initial cost, but the laboratory machinability tests indicate that in many applications a saving can probably be made in processing costs and in the general speeding up of production. This may result in a lower total cost per unit of the finished product unless considerable additional equipment is required to overcome health hazards due to lead fumes in welding and flame-cutting operations.

SILVER IN STAINLESS STEEL

A new type of stainless steel containing silver has been developed primarily to resist pit corrosion but, in addition to this attribute, presents other striking characteristics, such as free machinability, low work hardening, increased heat conductivity, and an ability to take high polish. According to articles in *Metals and Alloys*, January, 1940, and *Mining and Metallurgy*, January, 1940, the new steel was developed as a result of a research program sponsored by The Chemical Foundation, and carried out by C. L. Norton, R. S. Williams, John Wulff, Henry Uhlig, and A. L. Kaye at the Massachusetts Institute of Technology. Their problem was to investigate the phenomenon known as pit corrosion of stainless steel, to determine its causes and, if possible, to provide a cure.

It was determined, among other things, that the development of the pit involved the dissolution of metal in the steel by reason of the reaction of chlorine of sea water with metal components of the steel resulting in soluble corrosion products, i.e., the soluble chlorides of iron, nickel, and chromium. As the action progressed these soluble products leached away as formed, which permitted a continuance of the attack. It was discovered that, if 0.25 to 0.50 per cent of silver (an insoluble chloride-forming element) was added to, say, an 18-8 stainless steel, and if under such circumstances, it was finely and homogeneously dispersed in the alloy, the steel could be rendered inherently resistant to pit corrosion. The mechanism of the protection involves the formation of the insoluble silver chloride which serves as a protective film against further attack. If the silver is properly introduced in the steel it will be found in stable form in the ultimate alloy. Furthermore, when the proper technique is employed the initial 18-8 silver alloy may be reheated and repoured without any substantial loss of silver or, in other words, the silver 18-8 scrap may be used in production.

The form which the silver takes in the alloy is most interesting and, as it happens, such as to add materially to the practical value of the material. Microscopic spheroids of the silver are found throughout, both within the granular structure itself and between the grains. Already, the steel is being produced commercially as castings and in sheet form. It may also be forged and drawn.

An unexpected advantage of the new silver alloy was found in its greatly improved machining qualities. This is due to the fact that the minute spheroids of silver offer additional "points of departure" for the edge of the cutting tool. From tests which have been made, it is demonstrated that this improved machining will be at least 50 per cent better than with ordinary 18-8 alloy steel. The introduction of as little as 0.14 per cent of silver increases the thermal conductivity of the new steel over ordinary stainless steel as much as 26 per cent. Thus new uses are opened up for this alloy in fields which have previously been impossible with stainless steel because of its recognized low conductivity. Another feature of the new silver alloy is a material reduction in work hardening, which characteristic, coupled with the free-machining qualities, greatly facilitates machining operations. The alloy takes a very high polish, presenting a very uniform surface, which in itself inhibits corrosion.

Electrolytic Corrosion

POWER PLANT ENGINEERING

TREASURE ISLAND, site of the San Francisco World's Fair of 1939, has proved to be one of the most corrosive spots in the United States in so far as underground pipe and lead-covered cable are concerned, reports C. W. Geiger in an article appearing in *Power Plant Engineering* for February, 1940. Thin-walled No. 16 gage pipes which were calculated to have a life of 10 months, failed in 90 days. The domestic water sys-

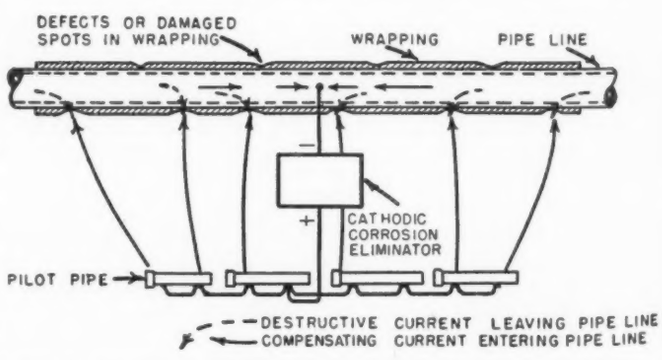


FIG. 1 DIAGRAM SHOWING THE PRINCIPLE OF PROTECTION AGAINST ELECTROLYTIC CORROSION

tem completed April 10, 1938, had its first failure due to electrolytic corrosion on July 22, 1938. The gas pipes failed even before the natural gas was turned into them. Since the story of how this underground corrosion was eliminated by electrical means is of interest to many mechanical engineers, the following abstract was prepared from Mr. Geiger's article.

The principles involved in combating electrolytic corrosion by electric methods are easy to understand. Corrosion of pipe is due to electric currents that flow from the pipe to the soil. These currents may be local and, therefore, the resulting damage is called local or self-corroded. At other times they may be due to stray railway currents or galvanic currents flowing along the pipe between different types of soil. These currents are called line currents and the destruction caused by them is referred to as electrolysis. These two types of corrosion require the same type of protection for the pipe, which is to have compensating current enter the pipe at one or more points. This is accomplished by connecting a cathodic corrosion eliminator, as shown in Fig. 1.

The positive terminal is connected to the pilot pipe or auxiliary electrode and the negative terminal to the pipe to be protected. The compensating currents from the cathodic corrosion eliminator shown by the full lines in the diagram pass from the pilot pipes in the soil, entering the pipe at various points throughout the line. At these points they neutralize the destructive currents shown by the dotted lines. With proper adjustment of the cathodic corrosion eliminator all corrosion is transferred to the pilot pipe which is proportioned to have a useful life of 30 or more years.

Gas-Turbine Test Results

POWER

THE high light of the 1939 Semi-Annual meeting of The American Society of Mechanical Engineers, held in San Francisco, July 10–15, from a technical viewpoint was a description by Adolphe Meyer, of Switzerland, of the development, design, and construction of combustion-gas turbines. In his paper, which appeared in the September, 1939, issue of MECHANICAL ENGINEERING, Dr. Meyer mentioned a 4000-kw gas-turbine-driven power unit (see Fig. 2) being built by his company for installation in a bombproof location in Neuchâtel, Switzerland. Since the tests at the plant were being carried out about the time of the meeting, these were not included in the paper. Since then, they have become available and appear in an article by Dr. A. Stodola, published in *Power* for February, 1940.

TABLE 2 TEST RESULTS OF 4000-KW COMBUSTION-GAS-TURBINE-DRIVEN POWER PLANT

TEST RESULTS

General			
Test number	1	2	3
Time	9:25–9:40	10:10–11:10	11:25–11:55
Duration, min	15	60	30
Barometric pressure	732.7 mm Hg = 14.177 lb per sq. in.		
Speed, rpm	3,020	3,020	3,030
Net calorific value of fuel oil, Btu. per lb	18,257	18,257	18,257
Efficiency			
Terminal output of generator, kw	0	4,021	3,057
Power at generator coupling, kw	0	4,184.3	3,193.8
Fuel quantity, lb. per hr	1,812	4,338	3,649
Specific fuel consumption, lb. per kw. hr	.....	1.078	1.193
Thermal efficiency at terminals, %	.....	17.38	15.67
Thermal efficiency at coupling, %	.....	18.04	16.37
For inlet air temperature of 68 F., the above efficiency values correspond			
to a speed, rpm	.....	3,000	3,000
to a terminal output, kw	.....	4,000	3,026
to a turbine inlet temperature, F	615	998.5	890.5
Compressor			
Temp. at compressor inlet, F	73.6	77.4	78.6
Temp. at compressor outlet, F	357.6	396.8	393.0
Abs pressure at compressor inlet, lb. per sq. in.	14.056	14.056	14.056
Abs pressure, compressor outlet, lb. per sq. in.	53.72	61.69	60.26
Pressure ratio	3.82	4.38	4.28
Weight of air, lb. per hr	496,436	491,264	498,347
Adiabatic power, kw	8,650	9,710	9,660
Efficiency (deducting bearing friction, etc.), %	84.4	84.6	84.9
Coupling output, kw	10,250	11,480	11,380
Gas turbine			
Temp. at turbine inlet calculated from fuel F.	627	1,025	917
Temp. after gas turbine, F	325	532	487
Abs pressure at gas turbine inlet, lb. per sq. in.	52.8	60.77	59.31
Abs pressure, gas turbine outlet, lb. per sq. in	14.21	14.22	14.215
Pressure ratio	3.7	4.25	4.15
Gas weight, lb. per hr	198,248	495,602	501,996
Adiabatic power, kw	12,000	17,725	16,460
Coupling output, kw	10,250	15,664.3	14,573.8
Efficiency from power, %	85.4	88.4	88.4
Over-all efficiency of the turbo-set			
Tot. eff. = Comp. eff. × turb. eff., %	72.1	74.8	75.0

Load and governing tests were carried out on July 7, 1939, at

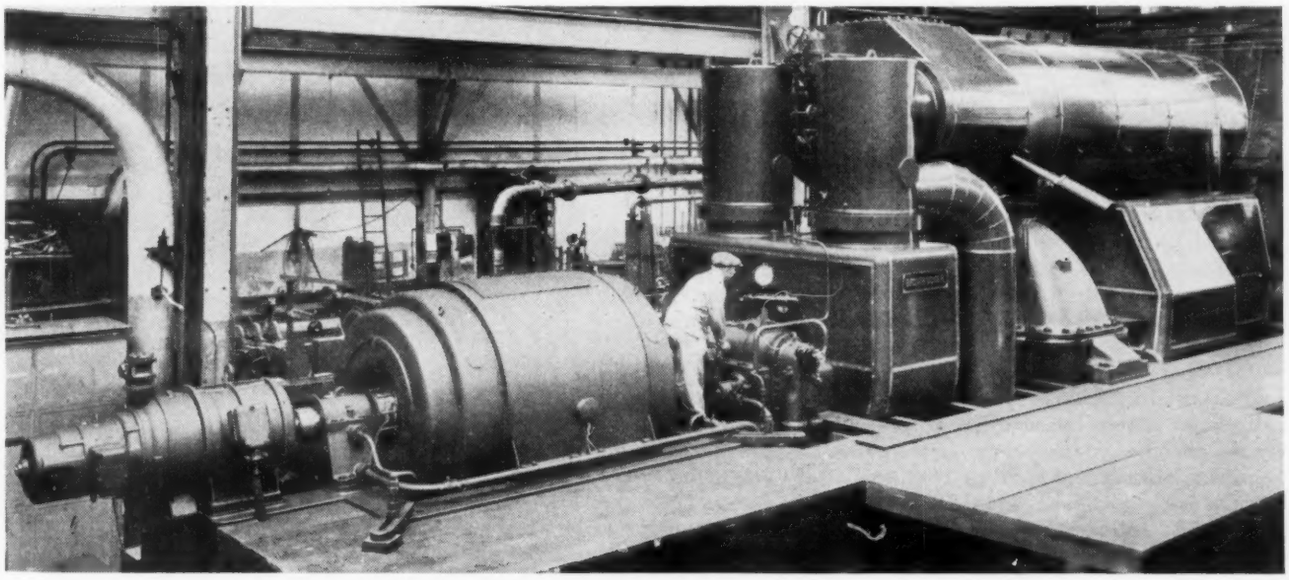


FIG. 2 COMBUSTION-GAS TURBINE BEING TESTED

the manufacturer's plant in Baden, Switzerland, under the personal supervision of Dr. Stodola, who was assisted by the Swiss Association of Steam Boiler Proprietors and of the test-laboratory staff of the Swiss Association of Electrical Engineers. The calorific value of the fuel was determined by the fuels department of the Swiss Federal Material Testing Laboratories.

The fuel consumption was determined by weighing, readings being taken every ten minutes. Mean readings and efficiency values are recorded in concise form in Table 2. A preliminary test using a standard nozzle determined the exhaust-gas quantity of the turbine. This made it possible, after deducting the weight of fuel fired, to calculate the speed-volume characteristics of the compressor.

The full-load thermal efficiency of 18.04 per cent at the generator coupling, according to Dr. Stodola, could be improved by the addition of an air preheater or other means. The manufacturer, however, deliberately refrained from including any heat-recovery apparatus to improve economy, as the unit is intended for use as a stand-by bombproof plant to run only a few hours per year. In addition to the simple and reliable design of the few main components, namely, compressor, combustion chamber, and turbine, there is the great advantage that no cooling water is required. Location of the plant is therefore independent of water supply. Other factors of equal importance are the low capital cost and extremely small space requirements with attendant reduced construction costs. Cubic space requirements of this installation, $70 \times 33 \times 20$ ft, are the lowest ever attained for a complete stationary plant of this output.

Messerschmitt Me-110 Airplane

THE AEROPLANE (LONDON)

MUCH secrecy has surrounded the development and construction of a new German two-engined fighter airplane designed by Prof. Willy Messerschmitt. Therefore, it is interesting to note that a complete description of this new airplane is given for the "first time in any tongue or any journal" in the Jan. 12, 1940, issue of *The Aeroplane* (London). The figures and estimates in the article are based on the observations of C. G. Grey and others who visited the Messerchmitt plant prior to the present war. The article includes a map of the disposition of the works of the company around the flying field just south of Augsburg, Bavaria.

The Me-110, as it is designated, was designed about three years ago, but it is only recently that it has been produced in great numbers. As shown in Fig. 3, the wing is straight tapered (2.7:1) with a small rounded tip. The ratio of root thickness to chord is 0.185, which is fairly thick. There are slotted flaps (20 per cent of the chord) and slotted ailerons with external mass-balance weights. The wing is in two pieces. Each half is connected directly to the side of the fuselage at four points, with $5^1/_2$-deg dihedral measured on the lower surface. As always in Messerschmitt types, there is a single spar. In the Me-110, it is at 39 per cent of the chord from the leading edge, a percentage which remains constant along the whole span. The wing is entirely metal-covered.

The standard version of the Me-110 now in service is known to have two 1150-hp Daimler-Benz DB 601, 12-cylinder inverted-vee liquid-cooled engines, each having a displacement of 2069 cu in. and a maximum speed of 2400 rpm. Like all modern German aviation engines, the DB 601 has no carburetors, but is equipped for direct gasoline injection. The latest models of this engine are said to have an output of 1360 hp, presumably for take-off.

Although the DB 601 appears to be the standard engine used in the Me-110, certain versions may have other engines, such as the 1200-hp Junkers Jumo 211. There are even rumors of the new Daimler-Benz x-engine, reputedly of more than 2000 hp having been installed. However, probably such an installation, if true, would be for experimental purposes only.

The characteristics of the Messerschmitt Me-110 are as follows:

Dimensions:

Span 55 ft; length 35 ft; height 10 ft, 9 in.; wing area 414 sq ft; and track 15 ft, 2 in.

Weights of structure and power plant (estimated):

Wing 2000 lb; fuselage 1600 lb; undercarriage 1000 lb; tail unit 300 lb; and power plant (including tanks) 5000 lb. Total weight 9900 lb.

Weights of disposable load (estimated):

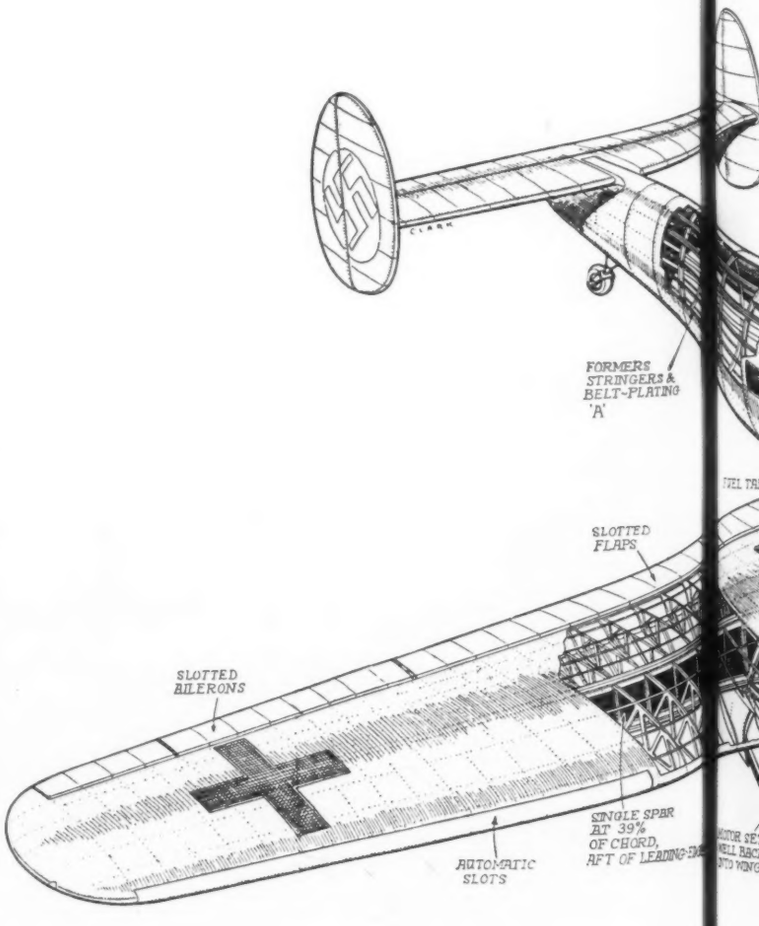
Fixed equipment 330 lb; crew (two) 400 lb; fuel (400 gal) 3000 lb; oil (28 gal) 250 lb; radio 120 lb; and armament 800 lb. Total weight 4900 lb.

Loadings:

Wing 35.8 lb per sq ft; power (take-off) 6.44 lb per hp; and span 4.9 lb per sq ft.

Performance:

Maximum speed should be about 365 mph at 16,500 ft. The range, with the airplane cruising at 15,000 ft, should be 820 miles at 365 mph, 1500 miles at 215 mph, and 1750 miles at 175 mph.



Engineering Student Enrollment

THE JOURNAL OF ENGINEERING EDUCATION

ENROLLMENT in engineering schools of the United States and Canada for the academic year, 1939–1940, both undergraduate and graduate, is given in a group of tables published by the Society for the Promotion of Engineering Education in its publication, *The Journal of Engineering Education*, January, 1940. The statistics were compiled by the society from figures supplied by 146 institutions out of a total of 153 giving instruction in engineering, as of Dec. 30, 1939.

Undergraduate registration for 1939–1940 was 105,892 (in 146 institutions) as compared to 1938–1939 when the number was 84,002 (in 122 institutions). Almost one quarter of this number, 24,891, were taking the course in mechanical engineering. To this should be added 3034 and 2303, which are the figures for the related courses of aeronautical and industrial engineering, respectively. Disregarding "unclassified" engineering courses, the next largest groups are electrical engineering with 15,680, chemical engineering with 15,268, and civil engineering with 11,091.

Purdue University again leads in the total number of undergraduate engineering students with 3681. Close behind it is Drexel Institute with 3558. Others with high enrollments are Armour Institute with 2903, Texas A.&M. with 2823, Illinois University with 2349, University of Michigan with 2151, University of Minnesota with 2112, New York University with 2069, and University of California with 2016. Drexel Institute has the largest evening-session enrollment according to its registration of 2718, followed by Armour Institute with 1616, Brooklyn Polytechnic with 1404, Johns Hopkins with 1251, and New York University with 1101.

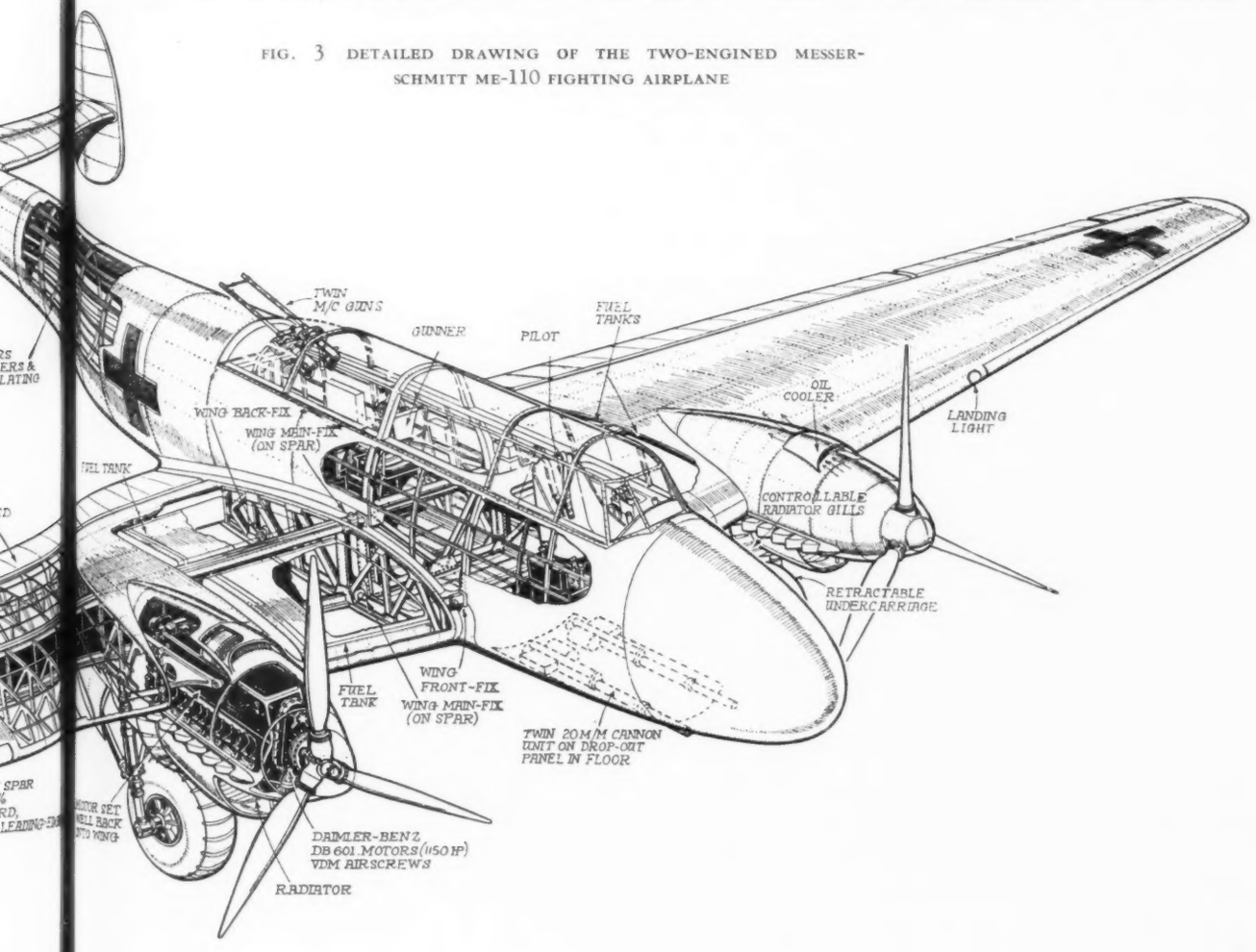
Graduate engineering students enrolled in schools in the United States and Canada numbered 4731 for the master's degree and 854 for the doctor's degree during 1939–1940. For 1938–1939, the figures were 4652 and 526, respectively. The University of Detroit, which had an enrollment of 702 for the master's degree last year, is not included in this year's tabulation. Heading the list for 1939–1940 is the University of Southern California with 598 students enrolled for the master's degree; last year the registration was only 39. Other schools with large enrollments are M.I.T. with 354 for the master's degree and 115 for the doctor's degree; Pittsburgh with 211 and 211; Armour with 350 and 10; Stevens with 313 and 0; Brooklyn Polytechnic with 274 and 20; and N.Y.U. with 253 and 17, respectively.

Progress in Power Generation

A.I.E.E. COMMITTEE ON POWER GENERATION

PRACTICES and developments in the power-generation field since 1933 were presented in a report at the winter meeting of the American Institute of Electrical Engineers, held in New York City, Jan. 22–26, 1940, by the Institute's Committee on Power Generation, of which Edward C. M. Stahl,

FIG. 3 DETAILED DRAWING OF THE TWO-ENGINED MESSERSCHMITT ME-110 FIGHTING AIRPLANE



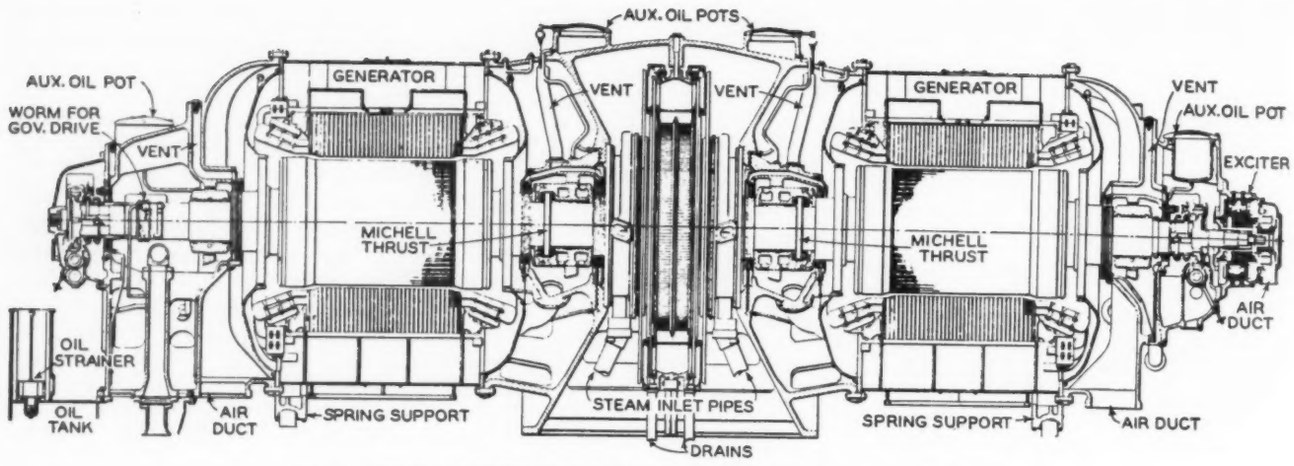


FIG. 4 SECTIONAL ELEVATION OF LJUNGSTROM TURBINE AND GENERATORS

member A.S.M.E., is chairman. The report gives a general picture with no attempt at describing individual projects or advancements. It divides itself naturally into three main parts, namely, steam, electrical, and hydro-plant practice. To enable the reader to find material which is of particular interest to him, a bibliography with 119 items is a part of the report.

During the last six years the most important advances have been made in the use of 3600-rpm, high-temperature, high-pressure steam turbines and hydrogen-cooled generators of sizes from 50,000 to 100,000 kw. Beside hydrogen cooling, increase in capacity has been made possible by the use of high-tensile steels for the fields and by improvements in detail design. Operation of these larger machines has been in the main satisfactory, although there has been some trouble with double-frequency vibration.

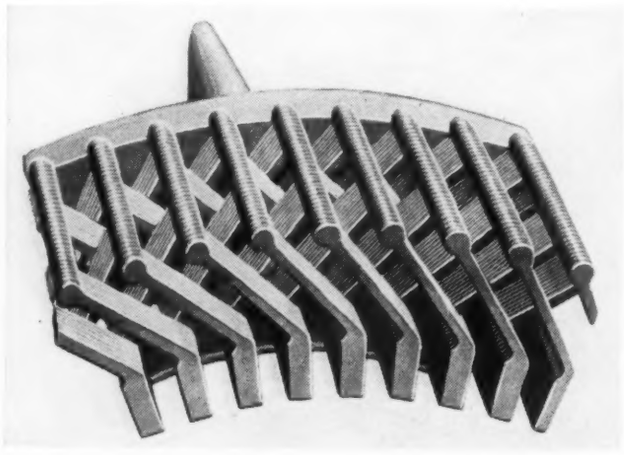
Boiler design and construction have been changed to insure sufficient circulation, and welding has taken an increasingly important part in almost every part of the plant equipment, both mechanical and electrical. Boiler sizes have not increased since the last report, remaining at a maximum of about 1,000,000 lb per hr. Recent large installations have developed the fact that the sectional-header boiler is not as desirable for high pressure as other types because of improper distribution of water circulation between individual tubes in the vertical headers. All high-temperature installations employ superheat control, consisting of some form of gas by-passing around part or all of the superheater surface. The trend toward pulverized coal for large boiler units has persisted. Direct-fired systems have been improved to a point where it is difficult to justify the additional expense of a storage system.

The period has marked the installation of many superposition units whereby the capacity of existing plants has been increased and the thermal efficiency materially improved. Because these stations are largely located near load centers from which distribution districts are served, there has been much rebuilding and extension of switching facilities of improved design and layout. These changes have greatly lessened the possibility of service interruptions from fire and other causes.

Considerable interest has been aroused in engineering circles by the installation in the Southwick Power Station, Brighton, England, of two 37,500-kw Ljungstrom turbogenerators, one of which is shown in Fig. 4. It is predicted that these double-rotation turbines in a single cylinder can be built up to a capacity of 100,000 kw. One of the major advantages claimed for this design is that the turbines may be started without the preliminary warming-up period.

Annual water-power figures are beginning to look like those for 1928 and 1929, predepression years. During 1938, about 750,000 hp of new capacity went into service, bringing the total capacity of water wheels to around 18,000,000 for the United States. At the present time, more than 2,000,000 hp of water-wheel capacity is under construction and work has been started on other projects representing an ultimate capacity of 750,000 hp for which the power units have not yet been ordered. A large part of this capacity is in plants being built by governmental agencies. There are, however, many projects being developed by public-utility and industrial companies, particularly in the northeastern and midwestern sections of the country. In 1937 and 1938, work was started or completed on over 60 of these projects, representing an initial capacity of 500,000 hp.

Welding is assuming an ever-increasing importance, not only in the maintenance of water wheels but also in their construction. A good illustration of this is, for example, in the Bonneville propeller-type units, practically all parts with the exception of the runners and shafts were constructed by welding.



SECTION OF NEW TYPE OF CAST ALUMINUM SQUIRREL-CAGE INDUCTION-MOTOR ROTOR WINDING

(Oblique end view shows one arrangement of bars, end rings, and fans. Built by General Electric Co. and called the "valvamp" rotor, it makes use of a unique shape of rotor slot and a special method of assembling rotor punchings to control the flow of starting current. As a result, without the use of a switch or other moving parts, current is permitted to flow in the outer squirrel-cage when the motor is started, thus producing high starting torque. Then, when the motor comes up to speed, current is allowed to flow through the entire rotor "winding," resulting in excellent running characteristics.)

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Unionization of Engineers[1]

TO THE EDITOR:

We noted with interest the article in the November issue of your publication, "Unionization of Engineers." It is our feeling that an objective and impersonal analysis and discussion of the question of unionization cannot but help redound to the benefit of the engineering profession. It has been the policy of our organization to invite the engineering societies to participate in our annual conventions, and at the last convention held December, 1938, in Washington, D. C., V. T. Boughton represented the American Society of Civil Engineers and was a guest speaker along with representatives of other engineering and architectural organizations.

We note that in the article James H. Herron quotes the aims of the FAECT as of November, 1933. It is our feeling that it would be proper in your next issue to state the aims and program of the FAECT as it now stands after amendment and changes through the last six years—the year 1933 was the year in which we first organized. For your consideration of this request I am enclosing a copy of the aims and objectives of the FAECT as approved by our last National Convention of 1938. In addition I am sending you excerpts from the report of our officers to that Convention on the question of professionalism and the relation of our union with the engineering societies.

This material may be published by you in whole or in part in your magazine. It is our feeling that by making this material available to your readers you will help the members of your society and the engineering profession to have a more completely rounded out picture of the question under discussion.

MARCEL SCHERER.[2]

[NOTE: The aims and objectives of FAECT and the excerpts from the report, entitled "Object of the Organization" and "Professionalism and Unionism," respectively, follow.—EDITOR.]

OBJECT OF THE ORGANIZATION

The object of the FAECT shall be to unite into one organization all employees doing work of a technical nature who are eligible for membership in order

(*a*) To maintain, protect, and advance the economic welfare of all technical employees.

(*b*) To extend the benefits of collective bargaining and to secure for technical employees means to establish peaceful relations with their employers.

(*c*) To maintain determined adherence to obligations and responsibilities under collective bargaining and wage agreements.

(*d*) To secure for members protection and full benefits of their patents and inventions.

(*e*) To secure legislation safeguarding the economic security and social welfare of the workers of America, to protect and extend democratic institutions and civil rights and liberties, and thus to perpetuate the cherished traditions of this Democracy.

(*f*) The FAECT, in order to advance its legislative and economic activities may cooperate with progressive groups in independent political action of labor.

PROFESSIONALISM AND UNIONISM

During the last few years and particularly within recent months, there has been a manifest increase in the attention devoted to unionism on the part of many sections of the technical professions. Unfortunately, publications including the *American Engineer*, the *Professional Engineer*, the *Engineering News-Record* and various architectural and chemical publications including *Chemical and Metallurgical Engineering*, all of which may be numbered among those publishing articles, correspondence, or editorials relating to unionism, have either displayed a markedly antagonistic attitude or have pooh-poohed the subject of unionism for technical professionals as one undeserving of serious consideration.

We have taken great pains to inform the technical professions of our program. Surely our program which calls for salaries and a work week commensurate with our social status, our experience and training, for compensation for overtime work, and for the adoption of a uniform and adequate code of procedure in employer-employee relationships, embodies no tenets hostile to the best interests of technical employees. We therefore most vigorously take issue with certain leaders of technical professional societies and publications who, in their zealous efforts to conceal or discourage an increasingly widespread growth of interest in, and sympathy with, raise the question of the incompatibility of trade unionism with a professional code of ethics and with professional standards. On the contrary, we in the Federation, seeking as we do to elevate the economic and social status of the technical employee, are making a definite contribution to the advancement of the entire technical profession.

It is not, and has never been, our desire to displace the various professional societies. The work done by the latter in the promulgation of uniform codes of technical procedure and in the development of high standards of materials testing and design, have contributed immeasurably to the technical progress of American industry. However, if the professional societies are to reflect the interests of the majority of their members, it is incumbent upon them to lend their support to an organization such as ours which contributes to the material advancement of all technical employees by *putting teeth into the professional codes of ethics!*

Some misguided officers of professional societies in our field have regularly attacked the principle of public works on the basis that such work as is being prosecuted rightfully comes within the province of the private practitioner. Knowing the facts as we do, we cannot express sympathy with this point of view of vested interests. The large portion of our national and local public-works program would never have reached its present annual volume had it not been for the widespread unemployment of the last few years and the consequent emergency which arose. The initiation of public works on the present scale has afforded direct employment to tens of thousands of technical employees and to hundreds of thousands of other workers. Public works has in turn stimulated private employment, directly through increase in the national income, and as a consequence has stimulated industry and construction generally. We therefore stand unequivocally for a broadened public-works program as an aid to both the private practitioner and to the individual employee.

Our Union has no narrow or special interests. We desire to contribute our talents and special abilities to the continued progressive development of the industries and resources of our great nation. We seek improved job tenure, outlawing of age discrimination and those many other ills which contribute to the degradation of our professional status. Which professional societies can, without injustice to their membership, refuse to support us in these efforts?

Our program speaks for itself. Our achievements, modest though they still are, prove that we are contributing to the advancement of

[1] A third group of letters commenting on an article "Unionization of Engineers," by James H. Herron, MECHANICAL ENGINEERING, vol. 61, no. 11, November, 1939, pp. 788–789 and 822.

[2] International Vice-President, Federation of Architects, Engineers, Chemists, and Technicians, New York, N. Y.

our profession in a very material manner. Unionism and professionalism can and should go hand in hand. *Unionism is true professionalism!*

TO THE EDITOR:

It is very gratifying to see that the management of the A.S.M.E. has at last been able to garner the intestinal fortitude to consider discussion of the so-called "Unionization of Engineers" as outlined by James H. Herron in the November issue of MECHANICAL ENGINEERING. It is not very gratifying, however, to note that, as Mr. Herron expresses it, "enough engineers have become union members to force the leaders of certain important American engineering societies to recognize and discuss unionization as a serious problem in the profession." Why is it that the Society has had to wait to be forced into recognition of a problem that has been privately under discussion by engineers for years?

Much of the subject matter of Mr. Herron's article revolves about that ethereal subject of the high ideals of the engineering profession. I wonder why we have to listen to this same old song and dance about engineering being a profession, when actually engineering is not now, nor has it ever been, a profession except in the case of a small and decreasing group of so-called consulting engineers. Engineering is a business pure and simple in which technical services are sold, supposedly at a profit. The big bulk of the membership of the Society are employed or are searching for employment in industry.

Engineering is an occupation engaged in for profit and the real heights of true professional attainment, where honor and individual recognition by fellows is the reward, is manifested by financial gain. In other words, the dollar is the mark of the game; and any statements to stir the pride and loyalty to the profession are mere empty words, unless evaluated in terms of dollar enhancement.

Unionization, as such, need not be offensive except that it has become offensive due to the unprincipled actions of certain union leaders. The same principles of collective bargaining if applied, as they should be, by the A.S.M.E. might better be employed under a different name and would probably be adopted by the setting up of reasonable and acceptable wage scales. Whether or not an attempt to enforce the payment of such wage scales should be by joining up with other collective-bargaining agencies is problematical, with the best answer being that that should be done only as a last resort.

Generally speaking engineers are a "self-hiring" group in that throughout industry it is customary for engineers to be hired by, and have their wages and hours established by, other engineers so that if a standard wage scale were to be established and accepted by the engineering societies it should be relatively easy to obtain payment of such scales. The control of specifications and purchases of supplies and equipment by member engineers should put sufficient pressure upon nonconforming employers to force the payment of accepted rates without resort to strike and other evils resorted to by the straight labor organizations.

No doubt there is a reactionary group within the Society composed of the employing members who will object strenuously to any such activity of the Society. Such an attitude will, I think, manifest itself as defeating its own purpose, because collective bargaining is here to stay; and that organization will longest survive which does the most to insure the best economic profit to its members, whether it be The American Society of Mechanical Engineers or some other organization that will surely come forth to perform this function if the A.S.M.E. much longer shirks its duty.

COURT KINNISON.[3]

TO THE EDITOR:

I asked an outstanding clear-cut young engineer of my acquaintance the question in the first paragraph of your letter[4] and requested that he write down his viewpoint. He has expressed the situation in a few words and to my mind has hit the nail directly on the head, and I am therefore enclosing his comments.

[The viewpoint of the young engineer mentioned in Mr. Palmer's communication follows.—EDITOR.]

A YOUNG ENGINEER'S IDEA OF UNIONIZATION

It seems to me that professional engineers, as an educated, trained group, should have enough initiative and resourcefulness to secure adequate compensation for their services to support a family without resorting to affiliation with labor unions and employing their tactics. Every engineer, who is worthy of the name, should have a horror of strikes and violence, where property is often destroyed. It is his obligation to society to be constructive and not destructive.

The value of engineer thinking is surely as important to industry as the resources to carry on that business and should receive equal consideration from management. Yet such does not seem to be the case in one industry, in particular, with which the writer is acquainted. The engineers in this concern drew up a set of coordinates and plotted a curve, using their respective salaries and years out of college to locate points on the curve. They then compared this curve with one published in the professional engineering publication and found that their curve fell 25 per cent below that of the average for engineers in that industry. The results of this investigation caused quite a stir in the organization and was made much of by the labor union in that particular town, where the company does pay its labor group well—in fact, above the community level. On the other hand, the dividends to the stockholders have been regular, and until the latest recession, quite generous.

If you have not seen it already, I believe you will be interested in a young engineer's views on this same subject which appeared in *Chemical and Metallurgical Engineering* for October, 1939, page 645, under the heading, "Readers' Views and Comments."

To my mind it is not so much a question of whether or not the aims and procedures of the labor unions are compatible with the ethics of the engineering profession, as it is a question of whether the handling and treatment of young engineers is such that they are not driven in self-defense to seek such membership.

The young engineer has invested capital in his education in the form of his cost plus the amount he would have been earning if he had gone to work instead of to college, and from which he anticipates an adequate return. In the early years this means not so much high salary as it does opportunity for anticipated promotion and ultimately a position with compensation above that of labor not equally skilled and trained. The young engineer expects afforded opportunity for such promotion and if he makes good, the promotion must follow with adequate compensation.

If the college training does not stick and if he cannot use it as a daily working tool, if the quality and quantity of his service is below the expected, then there should be a proper appraisal of his service followed by a blunt and frank explanation to him of his shortcomings and hence his failure to fulfill his anticipations.

In my judgment if these things are done, the young engineer will not need to wrestle with the question you submit. On the other hand, if they are not done and he does not understand the reasons why, and he sees organized labor, untrained and without any investment in

[3] Alameda, Calif. Jun. A.S.M.E.

[4] This letter was addressed to C. J. Freund, chairman, A.S.M.E. Committee on the Economic Status of the Engineer, in response to the committee's request for comments on Mr. Herron's article, and was forwarded to the Editor for publication. The question referred to was, "Are the aims and procedures of labor unions compatible with the ethics of the engineering profession?"—EDITOR.

education, secure apparently through unionization considerable recognition and pay entirely disproportionate with its value, and if he finds that this is a benefit which he can secure not because of the worth of his service but through organization, then the young engineer will join the union and he will not be troubled at all with much consideration of the question which your committee has prepared for discussion.

VIRGIL M. PALMER.[5]

TO THE EDITOR:

Mr. Herron's paper fairly poses the important question of unionization among engineers and candidly states his position with reference thereto. With that position I am fully in accord. One of the attractive features of engineering for a young man in past years has been the absence of any definite plane of horizontal cleavage between the professional and the subprofessional practitioners. Unionization, if it should become general, would make engineering a two-storied vocation, which would be practically lacking in stairs leading to the upper story. Unionization at once raises the fundamental concept concerning the social function of engineering, namely, whether it is a service to society on the plane of policy-determination or on the plane of skilled artisans under direction. Can the subprofessional be vitally and organically attached to the professional or is it merely assistance to be used by the professional? The union concept and the professional concept of engineering represent distinct and divergent patterns.

The difference in the two concepts of the function of the engineer goes to the roots of engineering education, more with respect to attitude than to content of courses. The union attitude, i.e., a militant demand for a preferred claim to compensation and privileges, contemplates the satisfactions of getting, while the professional attitude, recognizing a joint responsibility for the success of enterprises involved, seeks the satisfactions of creating. If the engineer is a trained technologist only, without an educated man's grasp of social and economic relationships, he may be a useful citizen as a member of a union, but he can scarcely expect to be accorded leadership in major issues of policy commensurately with men in recognized professions. Such leadership presupposes the judgments of an open mind, which the allegiance required by unionism of the predatory type virtually precludes.

For example, a major feature of policy is the National Labor Relations Act, many provisions of which are quite oblivious of social and economic consequences and are glaringly and ruthlessly directed toward certain primary objectives of the C.I.O. The fact that this Act with its subservient administration is the chief obstacle in the way of industrial normalcy has an alarming significance for the detached citizen interested in promoting the general welfare. Engineers who regard their calling as a profession can find no excuse for such subversive legislation, while a technician in a union affiliated with C.I.O. would perforce accept its flagrant partisanship as consonant with union strategy. A member of FAECT, through bartering his openness of mind and freedom of action for the bargaining leverage of union action, thereby discounts his opinions on questions of public policy, since the interests of perhaps 95 per cent of the population may run counter to his desires.

Many young engineers with a propensity for individualism and independence of thought are unwilling to make such a deal even though the wage advantage were great. As a matter of fact, no substantiation of material wage advantage has so far been adduced. Unionization has gone forward among the subprofessional groups chiefly because of their disappointment and their desire "to do something about it." The efficacy of that "something" has not been subjected to statistical scrutiny; joining the union so far has been largely a matter of emotional protest rather than a rational program toward amelioration.

As Mr. Herron well states, the engineering societies have an obligation to the subprofessional group, consisting usually of the younger members. The stairs to the upper story of the profession should be more plainly visible. A code of ethics applicable to the well-established engineers should assure compensation for engineering services commensurate with their value so that just earnings may be paid to assistants. Some firms of consulting engineers have solved the problem by sharing responsibilities and profits with the younger employees. Engineering departments of corporations and government bureaus have found group conferences effective in maintaining an undivided *esprit de corps*. Whatever the procedure, the question merits sympathetic attention. Unionization among engineers is an illogical remedy for a situation for which a proper solution lies largely with the older members of the profession.

C. C. WILLIAMS.[6]

TO THE EDITOR:

Perhaps the time will come when all organizations are unionized. Certainly that time is not in sight at present, and the advent of such an era can be construed only as a deterioration of our professional societies and the degradation of our standards. The foregoing statement is not intended to reflect in any way upon unionization. Any mature person has, during the period of his life, observed the benefits that have accrued to labor by unionization. Any fair-minded person should drop inherited prejudice against labor, and professional engineers may well be liberal in attitude toward borderline organizations such as surveyors and those that appropriate the designation "engineering" when little, if any, engineering is involved. I am personally convinced that parent organizations such as The American Society of Mechanical Engineers should maintain a parental attitude toward all of its members of every grade in every ramification of mechanical engineering. This should not be construed as a substitute to avoid unionization, but rather as a contribution to develop and maintain the high standards of professionalism set up by engineering societies.

E. O. EASTWOOD.[7]

TO THE EDITOR:

The National and State Societies of Professional Engineers are unalterably opposed to any attempt to unionize engineers, and our active opposition is predicated on recognition of the following facts:

1 Unionization would destroy the solidarity of the engineering profession. It disrupts. It divides. It sets class against class, employee against employer, union member against nonmember—instead of all pulling together as fellow members of one profession.

2 The usual methods of unions (coercion, strikes, picketing, closed shop, etc.) should be unthinkable in a profession. Such methods are inconsistent with all of the ethical ideals of the profession.

3 A union seeks selfish immediate advantages for its members even though the public suffers thereby or the long-range interests of the profession are sacrificed.

4 A profession occupies a position of public trust. It violates that trust if it unionizes to threaten or coerce the public.

5 Engineers, in particular, occupy a position of confidence and trust between capital and labor, and between employers and employees. Unionization is incon-

[5] Rochester, N. Y. Mem. A.S.M.E.

[6] Bethlehem, Pa.

[7] Seattle, Wash. Mem. A.S.M.E.

sistent with the highest discharge of that trust.

6 Transportation facilities, water-supply systems, and light and power services are dependent upon professional engineers for their uninterrupted maintenance and operation. Participation in, or passive support of, a strike which would interrupt or endanger the food, water, power, or light supply, or the transportation services to the population of a community would be a violation of the public trust "to safeguard life, health, and property."

7 Unionization places the sole emphasis on wages and hours, and on union membership, instead of emphasizing qualifications and quality of service.

8 Unionization tends to pull all members of a profession down to the same level, discouraging individual effort, loyalty, and ambition.

9 Unionization blinds its disciples to the common decencies of fair play, mutual consideration, and loyalty, and substitutes selfishness, vindictiveness, and prejudice. Under the strong feelings of unionized warfare, its disciples forget that it is a violation of professional ethics and honor "to attempt to injure the professional reputation, prospects, or business of another engineer."

10 Unionization is identified with the trades. Unionization of engineers undoes the work of years in winning public recognition of engineering as a profession.

11 Unionization is inconsistent with the professional spirit and attitude, which places service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations.

The foregoing considerations point to one unalterable conclusion:

For professional men, unionization is not the answer. Unionization has its place, but that place is not in the professions.

How then are we to improve the economic status of the engineering profession? To this insistent problem, the professional engineers' answer is on record. It is a program on which the entire profession should unite:

1 Increase public appreciation of the high value of the service of engineers.

2 Increase public recognition of the high qualifications and standards of the engineering profession.

3 Increase the demand for engineering services by stimulating the initiation of worthy public and private works, and by developing additional fields of engineering employment.

4 Reduce the oversupply of engineers by discouraging the competitive drive of engineering schools for student enrollment, and by raising the standards of admission and qualification.

5 Eliminate the competition of the unqualified, the incompetent, and the unethical, through registration and enforcement.

6 Eliminate the misuse and the misappropriation of the designation engineer, so as to increase public recognition and respect for those bearing this designation.

7 Develop, through professional organizations in which employers and employees work together, codes of recommended salaries and fees for engineers, and promulgate such codes as established by the profession (not by a union).

8 Through education and persuasion, in the name of the profession, induce employers and officials to respect the codes of recommended salaries and fees and to raise any lower levels of compensation to the standards recommended.

D. B. STEINMAN.[8]

[8] New York, N. Y.

Internal-Combustion-Engine Developments Abroad

TO THE EDITOR:

The two papers[9] under discussion are of great interest as presenting to engineers in the United States developments abroad.

It is stated by Mr. Bochet that extensive experimentation was necessary to obtain 70 psi mean effective pressure with a clean exhaust. Engine performance of this nature appears to the writer to be extremely poor for any modern engine since, usually, difficulties are not met until pressures of 100 psi or more are employed. It is possible that a very low volumetric efficiency existed, if the figures quoted actually referred to a modern design.

Mr. Bruce's reference to the Great Western rail-car applications might leave the impression that this was the first application of Diesel engines for this purpose. It should be pointed out that a high-speed lightweight Diesel engine, manufactured by Messrs. W. Beardmore and Company, was installed on the London Midland & Scottish Railway some 12 to 13 years earlier, to the writer's knowledge; it is more than possible that it was not the first such application.

E. T. VINCENT.[10]

TO THE EDITOR:

The impression given by Mr. Bruce's paper is that England is definitely a coal country, and that we cannot expect extensive Diesel development in a coal-burning country.

There is one other point which might have been mentioned in the paper on developments in Great Britain. There is a rather high fuel tax in England. Undoubtedly, such taxes have tended to discourage Diesel developments. The use of the grid or electric system has also helped curtail the extensive use of Diesels.

In the paper on European developments, something might have been said about experimental work on Diesels with higher mean effective pressures. The writer does not know whether this is widely advertised as yet, but it is his understanding through contacts with European manufacturers, that some Diesels in Europe are running with mean effective pressures as high as 250 psi.

Also it has been learned recently that certain high-pressure Diesels are operating in conjunction with exhaust-gas turbines. Engine is used to produce exhaust gas, and the turbine is attached to the engine, mounted alongside, and used as the main power unit. Part of the generation is obtained from the Diesel but the exhaust-gas turbine, being attached, is used to supplement the Diesel power. That is a new development which has not been tried in this country. It would be interesting to have a more detailed report on this development.

LEE SCHNEITTER.[11]

TO THE EDITOR:

Certainly Mr. Schneitter's remark about a mean effective pressure of 250 psi is a bit startling; the exhaust will be very hot. The idea of hooking an exhaust-gas turbine to a Diesel cylinder and using the latter as a furnace to generate hot gases seems a little dubious from a practical standpoint.

Some years ago, Elmer Sperry thought of a compound Diesel in which he was going to carry a mean effective pressure of approximately 250 psi and have the

[9] "Present Position of Heavy-Oil and Gas Engines in Great Britain," by A. K. Bruce, MECHANICAL ENGINEERING, June, 1939, pp. 429–436.
"Internal-Combustion-Engine Design in Europe," by Marcel Bochet, MECHANICAL ENGINEERING, July, 1939, pp. 525–529.

[10] University of Michigan, Ann Arbor, Mich. Mem. A.S.M.E.

[11] Plant Betterment Engineer, Ebasco Services, Inc., New York, N. Y. Mem. A.S.M.E.

high-pressure cylinder exhaust into a low-pressure cylinder, which in principle is the thing Mr. Schneitter mentions. However, Sperry had a reciprocating engine, while the turbine is a revolving machine. The difficulty was with the high gas temperature; as the gas passed from the high-pressure cylinder, Sperry could not maintain any form of closure against the temperature. The result was that the idea of obtaining a maximum mean effective pressure of 250 to 320 psi in a high-pressure cylinder was abandoned. In the writer's estimation, the same difficulty would be experienced in the exhaust-gas turbine, in trying to make the turbine the main power producer.

In connection with the Bruce paper, it is a fact, as Mr. Schneitter remarked, that the Diesel builder in England is handicapped in many ways. One thing is the electrical grid. The British electrical authorities will tell a manufacturer to shut down his power plant and buy electricity, and he has to do it. If England did not have export business, stationary Diesel engines would be practically nonexistent. There are but few stationary Diesel engines in England; about 135,000 hp. Several states in this country exceed that power.

The real development in England is in bus and truck engines. It is the writer's opinion, from a study of the literature published in Europe in regard to the high-speed Diesel, that England is far in advance of any other European country in utilizing the Diesel for buses. Certainly the Diesel bus has driven the gas bus off the streets of Liverpool, Birmingham, Manchester, and London.

L. H. MORRISON.[12]

TO THE EDITOR:

Regarding the problem brought up by Mr. Schneitter on the exhaust turbine, the writer would like to recall an experience about 18 years ago, when he was called upon to determine how much could be gained by an exhaust turbine from the exhaust of a Diesel engine. The prevailing opinion was that something like 20 per cent might be gained over the power that is utilized in the engine itself. However, the conclusion[13] was reached that about 3 per cent of the energy can be gained, assuming that the power is derived from the exhaust and not from the engine itself.

If we increase the back pressure and temperature so that they react to the engine, much more can be gained from the exhaust, but not from the waste heat but by robbing the engine. That, of course, does not mean exhaust turbines are not justified, and still less does it mean that supercharging is not justified, be it by exhaust turbine or by independent blowers. It means that exhaust turbines cannot increase fuel economy much.

P. H. SCHWEITZER.[14]

TO THE EDITOR:

Reverting to Mr. Schneitter's remarks concerning a European development in which an exhaust-gas turbine has been used to develop considerable power, the writer has read a fairly complete report on the subject. It was prepared by one of the Swedish companies involved. The scheme is about of this nature: The Diesel engine drives an air compressor and nothing else. The exhaust from the Diesel engine, together with some surplus air, is passed through an exhaust turbine. The sole source of external power is the exhaust turbine. The pressure at which the exhaust is supplied is reported to be about 55 to 60 psi gage. It was reported that that system has been in use for 6 or 8 years in a small river ship. It is now being used in an installation of about 5000 hp, so it seems to be practical. It is believed that a two-cycle engine is used to supply the power.

It may be said that the same development has a history in this country which never came to completion and probably is not known to many. It was originated by Charles Curtis, and the work was done about 1923 to 1925. Since the writer personally was carrying on the experiments at that time, it is possible to outline what occurred.

We were using a small opposed-piston single-cylinder engine. With it we developed brake mean pressures in excess of 200 psi. The exhaust was at about 100 psi, although we were aiming at a higher figure. Subsequently, it was reduced gradually, finally to about 30 psi. The exhaust was discharged against a specimen of material similar to that used for blading. There was no injury to this specimen, which represented the blades of an exhaust turbine. The temperature was not excessive, about 900 F.

As a matter of fact, during the entire progress of that development, nothing occurred which would indicate that the design could not succeed. It was just a case in which it was hard to interest financial support, and the thing went no further. From direct experience, it may be confirmed that it is possible to get brake-mean pressures such as those reported.

E. S. DENNISON.[15]

TO THE EDITOR:

At the time Mr. Dennison was associated with Charles Curtis, the writer was with the Electric Boat Company, and we were doing the work. It is perfectly true that we got indicated mean pressures well above 200 psi; in fact, about 260 psi. The actual useful exhaust pressure came down from 100 to about 40 psi, as Mr. Dennison indicated. We started with air injection and had maximum pressures in the neighborhood of 1500 to 1800 psi, but by use of mechanical injection and various devices, finally reduced them to between 900 and 1000 psi. From a mechanical point of view the development was successful. The exhaust was led into a silencer, and came out with terrific force.

Although a turbine had been ordered by Mr. Curtis, it was not delivered in time to run with the opposed-piston engine, and Mr. Curtis, who was very versatile, became interested in some other project; the experiments dwindled, and finally stopped because of lack of support.

With regard to the grid in England, to which Mr. Schneitter refers, the system does not appear to have been so much of a success as its protagonists would like to have us believe. Many business firms in England at the present time are installing individual stand-by sets, because of failures of the grid, such as they never had before when power plants were under municipal or ordinary ownership before the grid system went into effect.

It is understood that nearly every individual firm is putting in an engine or engines suitable for its plant, largely to guard against stoppages of grid supply; also, to guard against total loss of power as a result of air raids.

ERNEST NIBBS.[16]

TO THE EDITOR:

First, the writer notes with pleasure that in Great Britain they are making not only four- and six-cylinder engines but also five-cylinder engines. That was my hobby at one time. As they are more powerful than four-cylinder engines and cheaper than six-cylinder engines, it is strange that they are not more widely used.

Regarding the mean effective pressure of 70 psi, which Mr. Bochet said was

[12] Editor, *Diesel Power*, New York, N. Y. Mem. A.S.M.E.

[13] "How Much Can Be Gained From Exhaust Turbines," by P. H. Schweitzer, MECHANICAL ENGINEERING, October, 1925, pp. 860–861.

[14] Professor of Engineering Research, The Pennsylvania State College, State College, Pa. Mem. A.S.M.E.

[15] Engineer in Charge of Diesel Engine Development, Electric Boat Company, Groton Conn. Mem. A.S.M.E.

[16] Electric Boat Company, Groton, Conn.

difficult to get with smokeless operation by mechanical injection, either they did not know how to go about it or he is speaking about engine history, because in 1924 or 1925, the Western Machinery Company was building engines which operated without any smoke at mean effective pressures from 80 to 85 psi. For government work, we were limited, because the Government did not allow us to use mean effective pressures of more than 75 or 78 psi. That was not because of fear of smoke, but because, at that time, developments were behind what they are now and the higher mean effective pressures were creating trouble in respect to maintenance due to high temperatures. In our tests there was very little objectionable smoke observed at mean effective pressures as high as 120 psi. The writer does not know how long good operation would last at that rating, but for half an hour there would be no trouble.

In France they are still trying to use low-horsepower cylinders. Their 16-cylinder units develop 500 hp, or only 31 hp per cylinder. It reminds the writer of an engine which probably is not recalled by many. In 1909 or 1910, an airplane engine was built with 32 cylinders which developed something like 300 hp. Evidently in France they are still trying to have low-horsepower cylinders and many of them on the same crankshaft. In Germany, Diesel-engine developments are well advanced.

In the United States we have not yet standardized on the high-speed engine and our efforts should be so directed as to find the types most suitable for high- and variable-speed operation.

V. L. MALEEV.[17]

TO THE EDITOR:

A question was asked about the development of the gas turbine in this country. Although it is not widely known, there have been several gas turbines operating quite successfully in refinery service. For obvious reasons, the first applications were in industrial plants where air under pressure and at high temperature was necessary and where exhaust gas from the process was available at reasonably high temperature and pressure. As applied at the Sun Oil Company's refinery, Marcus Hook, Pa., an axial compressor raises air pressure to 45 psi, after which it is heated in a separately fired combustion chamber for delivery to the process. Waste gas from the process enters the gas turbine at about 900 F and leaves at about 600 F. A heat exchanger can be added if desired. The gas turbine drives the compressor and sufficient surplus power is produced to drive a small generator.

The practicality of such units depends upon the ability of materials to stand high gas temperature. Apparently this problem has been solved, as it is understood that, at Marcus Hook, a spare rotor was bought with the first unit but, after two years' experience proved it to be unnecessary, an additional casing was purchased and the rotor used to make a second unit.

Two gas turbines of this type are in operation in the United States and nine others are in various stages of erection or testing. A refinery installation has seen about two years of service in Italy and a unit, designed for straight power generation, is being installed for the City of Neuchâtel, Switzerland. The latter is of particular interest since it forms a complete emergency power plant for wartime service. No need for cooling water and a minimum of auxiliaries make it well suited for such service. The Neuchâtel unit will be installed in a tunnel driven into a mountainside for protection against bombing.

It is early to gage the investment cost of gas turbines, but all present indications are that units for straight power generation will cost considerably less than Diesel units of similar capacity. The thermal efficiency of the gas turbine is quite low compared with the Diesel; roughly about two thirds. But, since bunker-C fuel can be burned, the fuel cost is more or less comparable with a Diesel burning a higher-grade fuel. Thermal efficiency will increase as designers learn more of its characteristics and as better materials allow higher gas temperatures to be used. Thermal efficiency can be boosted by utilizing waste heat in the exhaust, but the same thing is true of a Diesel and this does not alter the relative efficiencies materially.

At present, there are no gas turbines in straight power-generation service in this country, although they would seem suited to applications in some parts of the country, particularly in the Southwest where oil is cheap and water scarce. The gas turbine represents an extremely interesting and important development and one that engineers in the internal-combustion field should follow closely. However, it presents no serious competition for the bulk of the Diesel field, as the smallest economical size seems to be about 2000 kw.

L. N. ROWLEY, JR.[18]

TO THE EDITOR:

Gas turbines are already under construction in the plant of the Allis-Chalmers Company, West Allis, Wis. In viewing one of these units, the writer was impressed with the fact that the turbine itself had only about five rows of blades, while the blower unit coupled direct had about fifteen rows of blades. One of the important problems connected with this type of prime mover is the fact that the power required for driving the blower is over three fourths of the power generated by the gas turbine. The function of the blower is to furnish excess air so that the gas temperature entering the turbine is about 1000 F instead of the 3000 or 4000 F which would normally result from combustion with a better air-fuel ratio. The limiting factor appears to be the permissible temperature at which the turbine blades can be operated. Hence, there is a big field for development in the metallurgy of gas-turbine blades.

Notwithstanding the present necessity for limiting the initial temperature, the thermal efficiency can be raised from about 15 to over 20 per cent by using an exhaust heat exchanger. There will have to be a considerable reduction in the amount of power required to operate the blower before the thermal efficiency of the gas turbine can even approach that of the Diesel engine.

G. C. WILSON.[19]

TO THE EDITOR:

In the survey of the present position of heavy-oil and gas engines in Great Britain by Mr. Bruce, reference is made to the Fullagar type opposed-piston engine. The figure of 100,000 bhp, given as representing the aggregate power of these units is now considerably exceeded. No less than sixteen engines ranging from 1500 to 2000 bhp each are at present under construction in the Rugby Works of The English Electric Company, the only builders of this engine.

The basic features of the Fullagar engine are completely different from any other engine built, and it may possibly be of interest to American engineers to know that this type of machine has become firmly established. At the beginning of its history it was doubted by some engineers that the construction was practical. The earlier examples have now been at work for 18 years. It is an interesting side light that, in only one case in plants where Fullagar units have

[17] Research Professor of Mechanical Engineering, Oklahoma Agriculture and Mechanical College, Stillwater, Okla. Mem. A.S.M.E.

[18] McGraw-Hill Publishing Company, New York, N. Y.

[19] Associate Professor of Mechanical Engineering, University of Wisconsin, Madison, Wis. Mem. A.S.M.E.

been installed, subsequent extension has been made with other than Fullagar units.

G. H. PAULIN.[20]

TO THE EDITOR:

The difficulty in the development of the Diesel in Europe has been largely that of nuisance elimination. The police authorities on the Continent have been very stringent in their regulations regarding smoke and odor. I think, when Mr. Bochet refers to low pressures, he refers to those pressures at which they have accomplished smokeless operation and wide variations in load under a wide variety of atmospheric conditions. In England they have gone a bit beyond what some of our people have accomplished here.

As the writer interprets the trend from outside and not from the viewpoint of the manufacturer, users everywhere are going to demand much greater output per cubic inch, and that movement is rapidly accelerating. That means much quicker burning and entails higher pressures. There are certain independents, like the Hesselman engine, tending to keep the pressures down. Quicker burning seems to indicate the open combustion chamber rather than a precombustion or auxiliary chamber. Reduction in weight and space, i.e., the greater output per cubic inch, is also accelerating the development of the high-speed two-stroke-cycle motor. The higher piston speeds and higher rotating speeds that have been mentioned lead designers in the direction of simpler valve motion. We have there something to look forward to in the future.

In experimental laboratories, in this country and in Europe, there are engines of far greater output per cubic inch and operating at far higher piston speeds than those which are now available commercially. They are far enough along to indicate that, within a reasonable time, they will be available for general application. We can reasonably expect Diesel motors of greater output, and consequently of lower cost with much wider application.

OLIVER F. ALLEN.[21]

TO THE EDITOR:

Professor Vincent pointed out that Diesel rail-car experiments in Great Britain date back at least to 1928, when the London Midland & Scottish Railway made exhaustive trials between Blackpool and Lytham with a four-coach train, the tare weight of which was 144 tons and the seating capacity 287. The power was supplied by a 500-hp Beardmore Diesel engine with electrical transmission. Reference to the experiments with this equipment will be found in a paper by T. Hornbuckle.[22]

Mr. Schneitter quite correctly points out the predominating influence of Great Britain's natural fuel on the type of prime mover used in that country. Nevertheless, the heavy-oil engine is regarded with due seriousness.

Mr. Morrison is not entirely right in his impression as to the powers possessed by the electrical authorities in Great Britain. So far as the private power user is concerned, there is no dictation, but strong competition, in which the Diesel engine does quite well. Mr. Morrison is correct in his view as to the significance of the export business so far as the British oil-engine industry is concerned. His appreciative reference to the high standard reached by British manufacturers of bus and truck engines will be noted with pleasure by the manufacturers concerned.

Mr. Nibbs points out that oil-engine manufacture in Great Britain has benefited from the demand for stand-by equipment, installed for the purpose of mitigating inconvenience due to failures on the national grid. Such equipment also takes the form of storage batteries, and it must be remembered that oil is a technical article which has to be imported.

In thanking Colonel Allen for his courtesy both in presenting the paper and in replying to the discussion, the author would like to concur in what he remarks about the onset of the two-stroke motor and the tendency toward simpler design. James Watt had a happy inspiration when he remarked that "in all things, but proverbially in mechanism, the supreme excellency is simplicity."

A. K. BRUCE.[23]

[20] Chief Engineer, Internal Combustion Section, The English Electric Company, Ltd., Rugby, England.

[21] Consulting Engineer, New York, N. Y. Mem. A.S.M.E. In the absence of Mr. Bruce and Mr. Bochet, Colonel Allen presented both papers.

[22] "The Application of Diesel Engines to Rail Traction," by T. Hornbuckle, Diesel Engine Users Association, London, November 11, 1936.

[23] Senior Partner, Robert Bruce and Sons, London, England. Mem. A.S.M.E.

A.S.M.E. BOILER CODE

Addenda to Par. CA-5 of Boiler Construction Code

THE Subcommittee of the A.S.M.E. Boiler Code Committee on the Care of Power Boilers has proposed adding to Par. CA-5 of the Suggested Rules for the Care of Power Boilers of the A.S.M.E. Boiler Construction Code the following:

However, operating evidence at this time shows no embrittlement in boilers designed to operate at or above 400 lb with welded, forged, or exclusively internally calked riveted drums. Therefore, no suggestions are given for the chemical control of the feedwater for such boilers.

Data on boilers designed to operate at or above 400 lb pressure, and having externally calked seams, show that some failures from embrittlement have occurred. A similar condition may exist where combined internally and externally calked seams are used, if the internal calking is not tight. These types of construction may permit the concentration of boiler water dissolved solids in the seams, and the need for chemical protection of such boilers is therefore indicated. Because data from boilers within this group using various chemical treatments for inhibition of embrittlement are not extensive, the sulphate-alkalinity ratios set forth above may be retained until additional controlled operating experience is available.

In clarification of the proposed additions to Par. CA-5 the Committee on Feedwater of the Subcommittee of the A.S.M.E. Boiler Code Committee on the Care of Power Boilers has prepared the following discussion. Comments on the proposed additions are solicited. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

DISCUSSION BY COMMITTEE ON FEEDWATER OF PROPOSED ADDITIONS TO PAR. CA-5

The necessity for additions to Par. CA-5 of the A.S.M.E. Boiler Construction Code relating to treatments for preventing caustic embrittlement of boilers built to operate at 400 lb pressure and over, had been apparent in communications addressed to F. M. Gibson, chairman of the Subcommittee of the Boiler Code Committee on the Care of Power Boilers in Service, prior to its December, 1937, meeting in New York, at which time it was decided to form a Committee on Feedwater.

The first work of the new committee

was to prepare a questionnaire to be submitted to each operator or owner of boilers coming within this class. Lists of such operators and owners were obtained from the different boiler manufacturers. More than five hundred names were supplied in this way. These manufacturers were also consulted as to the approximate time the specifications for the 400-lb pressure boilers were first inaugurated. This, according to company records, occurred during 1926 which was also the year the A.S.M.E. Subcommittee on the Care of Power Boilers first published its suggestions for preventing caustic embrittlement.

More than 50 per cent of the questionnaires sent out to lists of high-pressure-boiler operators were promptly returned without follow-ups. An active follow-up of the remaining plants over a period exceeding six months brought these total returns to 90 per cent.

The largest number of opinions regarding the value of the practices suggested by the subcommittee, as these were expressed under remarks in the questionnaire and in separate communications, were strongly opposed to the use of sulphate ratios for embrittlement protection. A number of the questionnaires gave incomplete returns, others were duplicates in that high-pressure boilers of two different makes were installed in the same plant, all of which reduced the number of plants on which the operator's summary was based. This was finally confined to 300 such returns.

The principal facts in these returns are given in the accompanying Tables 1 and 2. These tables show that 88.3 per cent accepted the A.S.M.E. Boiler Code subcommittee suggestions, clearly indicating this influence and serious consideration of any suggestions of this kind that are brought to its consideration. These same questionnaires showed that 75.7 per cent actually complied with the A.S.M.E. suggested ratios where the representative analysis of the boiler blow-down water was used as a basis for the computation.

TABLE 1 BASIS—ON STANDARD ADOPTED

Drum construction	A.S.M.E. ratios, maintained: 3 to 1	Under	Total plants	Boilers represented, per cent of total	Per cent maintained	Failures: Number	Failures: Per cent
External-calked	11	1	12	4	91.6	2	16⅔
Internal- and external-calked	13	4	17	5.7	76.5	0	0
Internal-calked	128	10	138	46.0	92.8	0	0
Welded	113	20	133	44.3	85.0	0	0
Totals	265	35	300		88.3		

TABLE 2 BASIS—ON ACTUAL ANALYSES REPORTED FOR REPRESENTATIVE SAMPLES OF BOILER CONCENTRATES

Drum construction	A.S.M.E. ratios, maintained: 3 to 1	Under	Total plants	Boilers represented, per cent of total	Per cent maintained	Failures: Number	Failures: Per cent
External-calked	8	4	12	4	66.7	2	16⅔
Internal- and external-calked	13	4	17	5.7	76.5	0	0
Internal-calked	112	26	138	46	81.2	0	0
Welded	94	39	133	44.3	70.7	0	0
Totals	227	73	300		75.7		

While this high percentage represented a definite intention on the part of the operators, periods sometimes elapsed before a new boiler went into service or some conditions interfered during the period of operations where it was found impossible to maintain the ratios. To determine the percentage of these lapses, another questionnaire was sent out embodying these possibilities to all operators of riveted seam boilers who had adopted the A.S.M.E. ratios. Out of 151 such requests, 112, or about 75 per cent, replies were finally received, in which it was found that 38 per cent failed at some time or other to maintain the suggested sulphate ratios. Of these, all exceeded a two-year period with the exception of two plants where the time in which they failed in this maintenance was 6 and 7 months, respectively.

Another more detailed tabulation of the facts reported by the operators is given in Table 3. This includes the average years the various classes operated, together with the ratio variations, silica content, phosphate concentrations, and pH limits.

The most remarkable information of all in this assembly of facts is that only two drum failures were reported by the operators. Failures of minor importance to tube ends were given but these were on reports covering the failure of tube ligaments or tube ends from causes other than caustic embrittlement in the high-pressure class. Some other failures to tube ligaments were reported but these were for boilers under the 400-lb class. Both the mentioned drum failures occurred to externally calked riveted jobs which represented but 4 per cent of the total number of plants included in the survey, no failures having occurred to the other types of drum construction in this high-pressure class.

Independent statements from all boiler insurance companies reported these same failures; also, that no failures had occurred to combined internally and externally calked jobs, straight internal-calked, or welded or forged jobs, all of which

TABLE 3

Number plants	Boiler pressure range	Calking of drums	Operating years: Avg	Operating years: Max	Ratio NaCl to alkalinity: Low	Ratio NaCl to alkalinity: Max	Ratio NaCl to alkalinity: Avg	Ratio Na_2SO_4 to alkalinity: Low	Ratio Na_2SO_4 to alkalinity: Max	Ratio Na_2SO_4 to alkalinity: Avg	Silica* (SiO_2): Low	Silica* (SiO_2): High	Phosphate* (PO_4): Low	Phosphate* (PO_4): High	pH
12	400	Ext.	10	16	0.02	0.33	0.18	0.06	4.3	3.0	16.0	160.0	40.0	180.0	11.1–11.5
10	400	Int.	9.4	12	0.06	3.3	0.86	0.03	0.53	0.22	7.0	22.0	40.0	110.0	10.5–11.0
4	400	Int. ext.	11	14	..	...	..	0	0.15	0.08	..	...	..	...	8.5–10.9
14	4–1300	Welded	6	12	0.15	1.3	0.64	0	1.5	0.45	0	3.4	1.0	100.0	8.5–11.3
13	4–700	Int. ext.	11	13	0.09	1.9	0.60	2.7	15.0	4.4	19.0	774.0	15.0	130.0	11.2–11.9
105	4–800	Int.	8.8	17	0.02	40.0	2.01	0.7	48.0	5.1	3.4	720.0	5.0	350.0	9.5–12.0
113	4–1500	Welded	3.6	11	0.03	10.0	0.64	0.9	33.0	4.26	4.0	195.0	5.0	279.0	8.5–12.5
6	4–1300	Welded	2.8	8	0.16	1.5	0.33	0.7	2.7	0.8	2.0	2.0	69.0	86.0	10.8–11.5
23	4–700	Int.	8.3	11	0.18	2.0	0.9	1.2	56.0	5.0	8.8	250.0	10.0	155.0	8.5–11.7

Of the total included in the summary, only two or $^{7}/_{10}$th of 1 per cent reported failures to water-exposed seams. In both of these cases there was a difference of opinion as to the cause, although both were outside calked jobs that had been subjected to the influence of high caustic concentrated waters during a short period of their operation.

* Parts per million.

confirmed the facts that were returned in the questionnaires.

First Case: This plant consisted of three cross-drum-type water-tube boilers, with external-calked seams, of 500 hp each, 450 lb operating pressure, installed in 1926; one 250-hp straight-tube sectional type at 125 lb pressure, and one 150-hp return tubular boiler at 125-lb pressure. This plant used a natural soda water, producing a high caustic alkalinity and very low sulphate ratio with no record of failures from embrittlement in the low-pressure boilers after many years' operations.

The first failure occurred to the high-pressure boilers in May, 1928. Investigation showed the drum in one of these boilers ruptured for the full length of 8 ft between rivet holes in the reinforced ligament of vertical circulating tubes at the bottom of the drum. Inspection showed that the rivets in affected seam could be "snapped off with a blow from a light sledge hammer. . . . A somewhat similar condition was found in two remaining boilers. . . . Drums were repaired and boiler placed in service at reduced pressure of 200 lb, until drums would be replaced. Outside investigations reported this as embrittlement cracking."

"Trouble had been experienced with leakage at the seams for a considerable time prior to the ultimate failure," and "large quantities of encrusting salts tended to form on the outside of the seams, particularly at the heads. . . . . was our conclusion, after the investigation had been completed, and taking into consideration the opinions of the various authorities on the subject, that the workmanship or methods of fabricating the drums largely contributed to this failure, although the nature of the cracking was different from that usually found in steam boiler operations, and that caustic concentrations probably were a contributory cause of the failure."

New drums were installed with inside-calked seams and treatment of disodium phosphate was inaugurated from the beginning, but feed was irregular. "One year and nine months after the new drums were installed . . . . a slight leak had developed at the edge of the bottom reinforced ligament and that when an attempt was made to eliminate the leakage *by calking the inside edge of the ligament and the heads of the rivets*, a rivet head was broken off. . . When the rivet was removed, an extremely fine crack was found in the shell plate." It was commonly agreed upon then "that the crack closely resembled the typical hair-like form of cracking usually associated with so-called caustic embrittlement."

Second Case: The second plant in the 450-lb pressure class to fail was also externally calked. Boilers here were installed in 1926. The A.S.M.E. sulphate ratios were inaugurated at the beginning of the operation. Carry-overs developed two months after this start and sulphate ratios were reduced, so that a ratio of from 1 to 1 to $1^1/_2$ to 1 was maintained. This lower ratio was held for about six months, when a change in design corrected the carry-overs, after which the 3 to 1 ratio was carefully maintained.

The drums of these boilers *always leaked considerably* at the riveted areas, and seal welding was applied at the edge of the circumferential butt straps in an attempt to stop leakage. This welding cracked after a short period of service. "While the seams were calked several times, we had reports of continued leakage and suspected the possibility of cracking being present in the riveted areas." The heads of the rivets were hammer-tested from time to time in order to see if there were any indications of breaking or cracking, but there was no definite external evidence of cracking until November, 1932, or six years after the boiler was first placed in service.

At this time, "the heads dropped off two rivets in the longitudinal seam of one of the boilers. . . . Three months later, two additional heads dropped off in the same seam. In March, 1933, the heads of four rivets were broken off under hammer test. . . . When butt straps were removed, a few very fine cracks were found and drums in two boilers were replaced by ones of welded construction. . . . An examination of the rivet heads revealed cracks resembling embrittlement cracking."

The information from the water-softener manufacturers covered a number of cases in which caustic-embrittlement failures had been reported as occurring because of improper ratios and where the condition was corrected when the ratios were established and maintained. None of these cases involved boilers in the 400-lb pressure class and over.

The Interstate Commerce Commission and Merchant Marine reported no records of boiler failures in the marine and locomotive fields coming under their inspection.

The U. S. Navy had never subscribed to the A.S.M.E. subcommittee suggestions and had no failures to report from caustic embrittlement.

Water supervisors for some outstanding railroad systems found the use of sulphates of little or no value for embrittlement-protection purposes, replacing these with organic compounds which have proved much more satisfactory.

It is understood that this conclusion is the result of a broad experience based on records of analyses over a number of years. These are to be made available for the committee's use at a later date when the subject of embrittlement protection treatments for this service and for boiler pressures below 400 lb are brought up for further studies. A questionnaire to be submitted for the accumulation of information for this purpose is in process of preparation at the present time.

Again, while the information supplied the committee through the operators and research interests differed widely as to sulphate values, they were in practical agreement as to the combination of circumstances required to produce embrittlement failures. The opinions of the individual subcommittee members also stood about half in favor and half against the sulphate values, although the final vote on the suggestions they extended was practically unanimous. This is logical, as no treatment was required for the principal decision.

The analysis of this issue is not difficult to understand, because

> Caustic embrittlement requires the simultaneous occurrence of three conditions:
> (*a*) Certain chemical conditions in the boiler water;
> (*b*) Physical conditions which permit high concentrations of the dissolved solids; and
> (*c*) Contact of the concentrated solution with highly stressed boiler metal.
> The careful workmanship and improved design which are characteristic of modern high-pressure boilers have eliminated (*b*) and (*c*). . . . No general recommendation is, therefore, believed necessary as to chemical control for the prevention of embrittlement for boilers designed for pressures of 400 psi and higher.[1]

The fact that only two out of 300 steam plants or $^7/_{10}$ of 1 per cent in this class reported steam-drum failures only in externally calked riveted drums permits such conclusions.

It is also reasonable to conclude that the outside-calked riveted drums are more susceptible to embrittlement because the open inside seam permits free leakage into it of boiler concentrates. Under these circumstances, tight outside seams permit leakage to evaporate to concentrations that constitute one of the three conditions responsible for embrittlement. This is assuming that high caustics are contained in the leakage and material for protecting the metals against embrittlement are a negative quantity.

Tight outside-calked seams and inside leakage are also responsible for the wide distribution of these same influences throughout the length of the seams. This is because of the characteristic manner in which joints of this type had been constructed mostly prior to 1926 and

[1] Conclusions presented to the committee by J. H. Walker.

which usually permitted of a closed passageway for the whole length of the seam. This is mentioned here because outside-calked joints are always potential sources for trouble, regardless of whether this calking is combined with inside calking or not. The fact remains that this type of construction allows for concentrations that have proved troublesome factors in jeopardizing boiler operations in the past and is not to be ignored when considering protective measures for both low- and high-pressure operations.

It should be made clear here that the committee, in not suggesting treatments for other types of construction for high-pressure boilers, was interested only in excluding those in which the seams have been proved to remain tight against the leakage from concentrated boiler waters and over a period that justified this action. It is also to be understood that the committee's suggestions have always been based on field experience with applied experimental data receiving due consideration.

Copies of the information collected for this purpose and which were supplied all Committee members are also on file in the Society records.

Meetings for the discussion of this work were held in December, 1937, in New York; on Dec. 6, 1938, in New York, and on Oct. 23, 1939, in Pittsburgh. Reports were extended by the chairman Dec. 6, 1938, March 10, 1939, Oct. 23, 1939, and Dec. 5, 1939.

The final work of the Committee on Feedwater for extending recommendations as to treatments for embrittlement protection purposes for high-pressure boilers was completed at the Philadelphia meeting, Dec. 5, 1939. Copies of these with the indicated approvals of the committee membership were supplied F. M. Gibson, chairman of the Subcommittee of the A.S.M.E. Boiler Code Committee, for submission to the Main Boiler Code Committee.

CYRUS WM. RICE, *Chairman*

Committee on Feedwater[2] of the Subcommittee of the A.S.M.E. Boiler Code Committee on the Care of Power Boilers.

[2] Members of the Committee: Cyrus Wm. Rice, *Chairman;* S. T. Powell; F. G. Straub; W. C. Schroeder; J. B. Romer; P. B. Place; Frank Henry; D. C. Carmichael; E. B. Powell; J. F. Morrison; R. C. Stratton; American Society for Testing Materials, represented by Max Hecht and J. H. Walker; Director, U. S. Naval Experimental Station represented by R. C. Adams; American Railway Engineering Association represented by R. C. Bardwell, R. E. Coughlan, and B. W. DeGeer; American Iron and Steel Institute represented by H. C. Siebert; and Technical Association Pulp and Paper Industries represented by W. G. MacNaughton.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

American Diesel Engines

AMERICAN DIESEL ENGINES. L. H. Morrison. Second edition, McGraw-Hill Book Co., Inc., New York, N. Y., 1939. Cloth, 6 × 9 in., 489 pp., 306 figs., $5.

REVIEWED BY OLIVER F. ALLEN[1]

MORRISON starts with an instructive review of the early development of compression-ignition engines. He refers to Carnot, almost one hundred years, and Beau de Rochas about thirty years before Diesel. Beau de Rochas continued Carnot's work by definitely outlining a cycle for an efficient heat engine. This cycle was first applied by Otto and Langen and has come to be known as the Otto cycle in general use today in gas and gasoline engines.

Happily, Morrison gives credit to Charles Akroyd Stuart who employed separate compression of the air and direct injection of the fuel in his Akroyd oil engine in England as early as 1888. Stuart developed the idea of the vaporizer or hot bulb with a neck-like connection to the cylinder, and in many respects anticipated the modern precombustion chambers. At about the same time, Diesel approached the problem more scientifically and proposed to utilize the Carnot cycle by securing the necessary heat for combustion of the fuel wholly from the rapid compression of the air in the engine cylinder to high pressure. Diesel used an open combustion chamber which was not preheated and into which the fuel had to be injected under very high pressure, whereas Stuart had his vaporizer preheated for starting and maintained it at a relatively high temperature during operation. He used lower pressures and lower temperatures than Diesel in the actual burning of the fuel.

Morrison shows that the first Diesel patent was antedated about four years by Stuart's first patent. (Actually Stuart's first patent was applied for July 31, 1886, in England, but his patent, covering automatic ignition with air admission into vaporizer and timed direct fuel injection at end of compression, was not applied for until May 8, 1890.) He also shows that the so-called Diesel engine in general use today, particularly in the smaller high-speed ratings, resembles Stuart's Akroyd engine more than Diesel's engine.

It is interesting to note that the American rights under Diesel's patents were obtained here in 1896, while Stuart's engine under the trade name of Hornsby-Akroyd was built in this country as early as 1893, and the Weiss hot-bulb engine of Mietz and Weiss was developed in this country and the first ones were built in 1894. Thus the three types: The hot-bulb, crankcase-compression, two-stroke-cycle, low-compression, low-temperature engine of Weiss; the higher-compression four-stroke-cycle Akroyd engine with direct injection of fuel; and Diesel's engine of very high compression with fuel injected by air blast, were all developed commercially in the United States during the last ten years of the nineteenth century.

Morrison goes on to describe in considerable detail the various types of air-injection and direct-injection engines now produced commercially in the United States, and includes chapters describing the parts of typical engines, such as frames, bearings, crankshafts, pistons, connecting rods, cylinders, and valves. There is a chapter on combustion of fuels, one on oil-engine installation, one on lubrication, and one on cooling systems.

In describing the various parts, the author depends almost entirely on showing mechanical designs and gives little information regarding the materials used to carry out the designs. The book does not tell what may be expected in the way of fuel- and lubricating-oil consumption for the various types of engines described, nor does it give any hint of the weights per horsepower or the relative costs of installation and maintenance. It leaves the reader in the dark as to the relative net cost both of original installation and of operation of slow-speed heavy engines and high-speed lightweight engines.

As Morrison definitely restricts his book to existing commercial engines in the United States, there is no reference to many interesting and useful developments of engines of lighter weight and higher rotative speeds than those described in the book. While it is true that many of these are still in the experimental stage and not generally available commercially, there are some which

[1] Consulting Engineer, New York, N. Y. Mem. A.S.M.E.

might properly have been mentioned, including for instance, the Guiberson radial air-cooled Diesel which has been produced commercially in considerable quantities.

The author is to be congratulated on the thoroughness of the revision of the 1930 edition. This 1939 edition is a much more comprehensive book and should be very useful to students and engineers who wish to know about the Diesels which are now commercially available in this country.

Cast Metals Handbook

CAST METALS HANDBOOK—1940 Edition. American Foundrymen's Association, Chicago. Cloth, 6 × 8⅞ in., 177 figs., 532 pages, $5.

REVIEWED BY LOUIS JORDAN[2]

THE second edition of this handbook contains about a hundred more pages than the first edition (and with considerably more on each page) but on thinner paper and makes a volume no thicker than the earlier edition.

In the new edition some fourteen pages of new material have been added on the significance of strength and ductility tests of metals; a new section added on considerations in designing steel castings; the section on properties of cast iron has been considerably expanded; that on malleable iron reorganized and expanded; and the table of contents made into a much more detailed outline of the book and a more convenient guide to the exact pages containing any desired information. Similarly a more complete and detailed index makes for more convenient use.

The main sections of the handbook include recommendations to casting designers; recommendations to buyers; data on cast steel; on malleable iron; on nonferrous alloys; and on cast iron.

The new edition is in many ways a more complete and convenient handbook and reference work than the original edition. While it may be entirely a matter of personal preference with the present reviewer the paper does seem more pleasing to handle and the type more pleasing to read than in the 1935 edition.

Books Received in Library

FINDING AND PRODUCING OIL. Prepared and published by Division of Production, American Petroleum Institute, Dallas, Texas, 1939. Cloth, 8 × 11 in., 338 pp., illus., diagrams, charts, maps, tables, $3. This volume is an attempt to outline the present state of the art of finding and producing oil and to indicate the various services and facilities, such as manufacturers, suppliers of equipment, consultants, contractors, educational facilities, that are available. There is information on laws and regulations, and extensive bibliographies are included on all important phases of the producing branch of the oil industry.

HANDBOOK OF CHEMISTRY AND PHYSICS, Twenty-third edition. Edited by C. D. Hodgman. Chemical Rubber Publishing Co., Cleveland, Ohio, 1939. Cloth, 5 × 7 in., 2221 pp., tables, cloth; de luxe edition, $6; regular edition, $3.50. This valuable reference work has undergone the customary annual revision. In addition to changes made to bring the information up to date or improve its presentation, a considerable amount of material has been added on subjects not previously covered. Data from the fields of chemistry, physics, metallurgy, electricity, and mechanics are included in this compilation.

HANDBOOK OF PHOTOGRAPHY, edited by K. Henney and B. Dudley. McGraw-Hill Book Co., Inc., Whittlesey House, New York, N. Y., 1939. Leather, 6 × 9 in., 871 pp., illus., diagrams, charts, tables, $7.50. This comprehensive, one-volume encyclopedia of photography, the work of 23 specialists, presents a thorough exposition of the serious aspects of the technique of the photographic process and the scientific basis underlying photography and its applications. Photomicrography, motion pictures, color, speed and infrared photography, and other specialized adaptations are covered. A bibliography accompanies each chapter, and reference tables of technical data are appended.

HOLZSCHUTZ GEGEN FEUER und seine Bedeutung im Luftschutz. By L. Metz. V.D.I. Verlag, Berlin, Germany, 1939. Paper, 6 × 8 in., 148 pp., illus., diagrams, charts, tables, 12 rm. The relation between combustibility and other properties of wood is discussed. The chemicals and methods for fireproofing are described, requirements to be met are stated and efficiency tests are given. There is a brief introductory chapter on the significance of fireproofing as an element in air-raid defense.

DER KONDENSATOR IN DER FERNMELDETECHNIK. (Physik und Technik der Gegenwart, Bd.6.) By G. Straimer. Verlag von S. Hirzel, Leipzig, Germany, 1939. Paper and bound, 6½ × 9½ in., 229 pp., illus., diagrams, charts, tables; paper, 12.80 rm; bound, 14 rm. This work provides a comprehensive account of the theory and practice of condensers for radio use. The first part discusses the theory of the electrical field, derives the important capacity formulas and shows their applications. Part two presents the electrical, thermal, and mechanical properties of the dielectrics used in condensers and considers their use under various operating conditions. Part three describes the construction and use of the different types of condensers. A lengthy bibliography of German publications is appended.

KUNSTHARZPRESSTOFFE UND ANDERE KUNSTSTOFFE, Eigenschaften, Verarbeitung und Anwendung. By W. Mehdorn. Second enlarged edition, V.D.I. Verlag, Berlin, Germany, 1939. Cloth, 6 × 8 in., 300 pp., illus., diagrams, charts, tables, 15 rm. This concise, comprehensive work covers the composition, production, and types of synthetic plastics and certain other synthetic materials; including their physical, chemical, mechanical, and electrical properties. Considerable space is also devoted to the methods and equipment for the manufacture of products from these substances.

MASTER BOILER MAKERS' ASSOCIATION, Official Proceedings of the 1939 Annual Meeting, Chicago, Ill., Oct. 17–19, 1939. Cloth, 6 × 9 in., 263 pp., illus., diagrams, charts, tables, $3. In addition to the text and discussion of the technical papers presented at the meeting, covering boiler feedwater, apprentice training, and various phases of the construction, inspection, and testing of boilers, there is a résumé of association affairs and a list of members.

MECHANICAL INVENTIONS OF EMANUEL SWEDENBORG, translated and edited by A. Acton. Swedenborg Scientific Association, Philadelphia, Pa., 1939. Paper, 6 × 9 in., 51 pp., diagrams, $0.60. This small work comprises all the known mechanical inventions by Emanuel Swedenborg. They have been gathered from five different sources, and the text and illustrations have mostly been taken directly from the originals.

MECHANICAL WORLD YEAR BOOK, 1940, 53rd Year. Emmott & Co., Ltd., Manchester and London, England. Cloth, 4 × 6½ in., 360 pp., diagrams, charts, tables, 1s 6d. This well-known little annual provides at very low cost a selection of information on steam boilers, electric arc welding, toothed gearing, internal-combustion engines, and other mechanical topics. The matter included is chosen with a view to its practical usefulness.

MICROSCOPE. By R. M. Allen. D. Van Nostrand Co., New York, N. Y., 1940. Cloth, 6 × 9½ in., 286 pp., illus., diagrams, tables, $3. This is a simply written practical text on the theory and manipulation of the microscope. The underlying optical principles are explained, the modern American instruments and accessories described, and directions given for preparing material. A bibliography and a glossary are included.

PHYSICAL EXAMINATION OF METALS. Volume 1, Optical Methods. By B. Chalmers. Longmans, Green & Co., New York, N. Y.; Edward Arnold & Co., London, England, 1939. Cloth, 6 × 9 in., 181 pp., illus., diagrams, charts, tables, $4. The application of the various branches of physics to the investigation of metals is to be covered in two volumes. This first one, on optical methods, explains the underlying physical theory, describes the more important applications that have been made and, in some cases, describes the technique so that the reader can apply it himself.

REFRACTORIES FOR FURNACES, KILNS, RETORTS, etc. By A. B. Searle. Crosby Lockwood & Son, London, England, 1939. Cloth, 5 × 7½ in., 102 pp., illus., diagrams, charts, tables, 3s 6d. The characteristics of the chief raw and manufactured refractory materials are briefly described, with an explanation of the processes and machinery employed in their production.

REIBUNG UND VERSCHLEISS. Vorträge der V.D.I.-Verschleisstagung, Stuttgart, 28–29 October, 1938. V.D.I. Verlag, Berlin, Germany, 1939. Paper, 6 × 8 in., 189 pp., illus., diagrams, charts, tables, 10 rm. This collection of papers contributed to a session of the V.D.I. committee on material research presents the views of experts on numerous phases of the problem of wear in machinery. Through the selection and proper treatment of materials, the adjustment of work conditions and processes, and certain other precautions put forth in these papers, it is considered that material loss will be lessened and efficiency increased. The discussions of the papers are included.

[2] Contributing Editor, *Mining and Metallurgy*.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

A.S.M.E. 1940 Spring Meeting in Worcester, May 1-3, Stresses Engineering Service

Diversified Program of Events Scheduled as Worcester Section Celebrates 25th Anniversary

GREATER service to industry and the public by the profession of mechanical engineering, has been selected as the theme for the 1940 Spring Meeting of The American Society of Mechanical Engineers, which is to be held in Worcester, Mass., at the Hotel Bancroft, May 1–3, under the sponsorship of the Society's Worcester Section. This theme, according to Prof. Charles M. Allen, chairman of the General Committee in charge of arrangements for the Meeting, is more than appropriate since the Worcester Section, founded in 1915, will be celebrating at the same time 25 years of service to the community by the Section and its members.

Worcester, sometimes called the "city of diversified industries," owes much to the mechanical-engineering profession because it was the activities of mechanical engineers which made possible many of its manufacturing plants. Among these who have founded and developed these plants, and all of whom are members of the A.S.M.E., are Fred H. Daniels, president, Riley Stoker Corporation; George F. Fuller, mechanical engineer and chairman of the board, Wyman-Gordon Co.; Aldus C. Higgins, president, Norton Co.; John W. Higgins, president, Worcester Pressed Steel Co.; George I. Rockwood, founder of the Rockwood Sprinkler Co.; Paul B. Morgan, president, Morgan Construction Co.; Howard E. Reed, president, Reed & Prince Manufacturing Co.; Otto Wechsberg, president, Coppus Engineering Corporation; William M. Whitney, president, Baxter D. Whitney & Son; Arthur J. LaCroix, president, Hyde Manufacturing Co.; Albert Palmer, engineer in charge of research and development, Crompton & Knowles Loom Works; Charles H. Turner, principal engineer, Pullman Standard Car Manufacturing Co.; Lawrence R. Ball, chief power engineer, Whitin Machinery Works; Fiske R. Jones, director and superintendent of production, Simonds Saw & Steel Co.; and many others.

HARRINGTON CORNER, WORCESTER, MASS., BUSINESS CENTER; CITY HALL AT RIGHT

MODERN WING OF JOHN WOODMAN HIGGINS ARMORY AT WORCESTER

Technical Sessions

Four groups of simultaneous technical sessions, numbering 13 in all and having 27 papers for presentation, will be held during the three-day meeting. The different topics to be covered at these sessions include iron and steel, steam power, drying in process industries, machine shop practice, fuels, management in the machine shop, boiler feedwater, hydraulics, heat transfer, and materials handling. All of the sessions will be held at the Hotel Bancroft with the exception of the hydraulic sessions which will take place at the Alden Hydraulic Laboratory of Worcester Polytechnic Institute, located at Chaffins-in-Holden, a few miles from Worcester. The complete program will be published in the next issue of MECHANICAL ENGINEERING.

Social Events

All participants in the Meeting will be accorded guest privileges for golfing every day of the Meeting. Following the opening technical sessions on Wednesday, May 1, a general luncheon will be held in the ballroom. Professor Allen will preside. Mayor William A. Bennett of Worcester and President Wat Tyler Cluverius of Worcester Polytechnic Institute will deliver addresses of welcome to which a response will be made by President Warren H. McBryde of the A.S.M.E. The chief speaker will be Dr. John F. Tinsley, president of Associated Industries of Massachusetts, and president and general manager of Crompton & Knowles Loom Works. Those men who de-

MEDIAEVAL WING OF JOHN WOODMAN HIGGINS ARMORY AT WORCESTER

sire to do so may attend an informal reception and entertainment at the Worcester Art Museum that evening.

Following a cocktail hour on Thursday evening, May 2, the formal banquet will be held in the ballroom, with Admiral Cluverius as the toastmaster. The address will be the "Progress Report of an Amateur Economist," which will be given by Ralph E. Flanders, past-president of the Society, and president, Jones & Lamson Machine Co., Springfield, Vt.

Women's Program

A complete and interesting program has been prepared for the women in attendance at the meeting by Mrs. Ralph F. Gow and her committee, which consists, at the present time, of Mrs. O. B. Denison, Mrs. F. Harold Daniels, Mrs. R. Sanford Riley, Mrs. John W. Higgins, Mrs. Albert J. Gifford, Mrs. Frank N. Naughton, Mrs. F. E. Banfield, Jr., and Mrs. Charles M. Allen. The detailed program follows:

WEDNESDAY, MAY 1

9:00 a.m.

Registration at Hotel Bancroft

12:30 p.m.

General luncheon for both women and men

2:30 p.m.

Trip by bus around Worcester to various points of interest, including visit to John Woodman Higgins Armory, where tea will be served by Mrs. Higgins.

8:00 p.m.

Informal reception and entertainment at Worcester Art Museum

THURSDAY, MAY 2

9:00 a.m.

Registration at Hotel Bancroft

1:00 p.m.

Trip by bus to Tatnuck Country Club for luncheon with bridge and sewing in the afternoon

6:00 p.m.

Cocktail hour in Crystal Room, Hotel Bancroft

7:00 p.m.

Formal banquet in ballroom, Hotel Bancroft

FRIDAY, MAY 3

9:00 a.m.

Registration at Hotel Bancroft

11:00 a.m.

Trip by bus to home of Mrs. F. Harold Daniels, where Mrs. Daniels will give a coffee party for the women

Inspection Trips

Members will be given ample opportunity to visit many of the manufacturing plants which are located in and about Worcester. As the following program indicates, all trips will be made in the afternoon on each of the three days of the Meeting. Members will also be given an opportunity to visit other plants by making arrangements with the committee. The schedule of plant trips is given in the next column:

WEDNESDAY, MAY 1

2:00 p.m.

Norton Co.—power plant and manufacturing departments

Rockwood Sprinkler Co.—fire-prevention demonstration laboratory

THURSDAY, MAY 2

2:00 p.m.

Simonds Saw & Steel Co.—windowless factory at Fitchburg, Mass.

Crompton & Knowles Loom Works—testing laboratory, foundry, and factory

Worcester Pressed Steel Co.—factory and John Woodman Higgins Museum

FRIDAY, MAY 3

1:30 p.m.

Rockwood Sprinkler Co.—fire-prevention demonstration laboratory

Leland-Gifford Co. and *Baldwin-Duckworth Chain Co.*—manufacturing plants

Wyman-Gordon Co. and *Worcester Polytechnic Institute*—metallurgical laboratory at the manufacturing plant and the foundry, manufacturing shop and laboratories at the Institute

Alden Hydraulic Laboratory, Worcester Polytechnic Institute

Where Large Variety of Model Testing and Research Work Is Done

THE Alden Hydraulic Laboratory of the Worcester Polytechnic Institute is situated in the village of Chaffins in the township of Holden, Mass., five miles north of the Institute.

The Laboratory is located on a natural water privilege so that no pumping is necessary. The Institute has complete control over the reservoir, making it possible to draw from this supply from maximum to minimum flow without interfering with any power project below.

The Laboratory buildings and equipment have been materially increased in the last few years, making it possible to carry on a large variety of model testing and research work.

There will be road maps available showing the location of the Laboratory relative to the Bancroft Hotel, headquarters for the A.S.M.E. Spring Meeting in Worcester, May 1–3, 1940.

ALDEN HYDRAULIC LABORATORY

A.S.M.E. Washington, D. C., Section Host to Officers and to Student Members

Dinner and Meeting Held During Annual Meeting of American Engineering Council

TAKING advantage of the fact that several A.S.M.E. officers and members from other parts of the country were in Washington, D. C., to attend the Twentieth Annual Assembly of the American Engineering Council, of which the Society is one of the member organizations, members of the Washington, D. C., Section met with them for dinner at the Hotel Harrison, on Thursday evening, Jan. 11.

A.S.M.E. Officers Speak

H. G. Thielscher, chairman of the Section, acted as toastmaster, and presented James W. Parker, vice-president of the Society, who addressed the members for President Warren H. McBryde, whose illness had forced him to be absent. Harvey N. Davis, past-president of the Society, held the interest of the many student members present, as well as the older men, by telling them about the rapidly growing field of powder metallurgy and forecasting some of its possible applications. A. A. Potter, also a past-president of the A.S.M.E., called attention to the Society's new membership booklet "Do You Belong?" and emphasized the so-called nontangible benefits of association with engineers in national engineering societies.

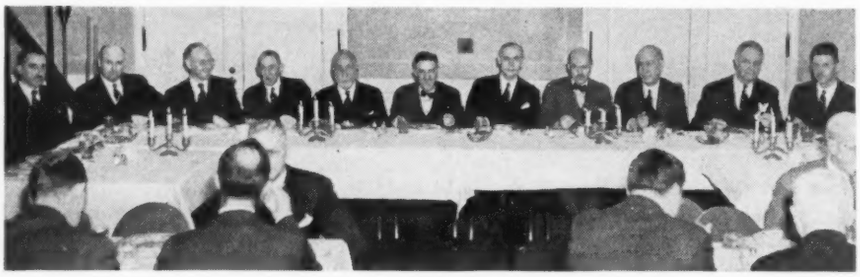
30 Student Members Present

Mr. Thielscher then introduced several officers and distinguished members of the Section and called upon the thirty or so student members from Catholic University, George Washington University, and the University of Maryland. C. E. Davies, secretary of the Society, when called upon to speak, introduced various other Society members present and addressed a few appropriate remarks to the student members. Huber O. Croft, professor of mechanical engineering at the State University of Iowa, spoke of the advantages of affiliation with the various Junior Groups now active in many A.S.M.E. Local Sections, and C. F. Scott told how he had started the student branch when he was president of the American Institute of Electrical Engineers. A short business meeting of the section followed the dinner.

THIRTIETH ANNIVERSARY MEETING OF A.S.M.E. BOSTON SECTION, JANUARY 11, 1940

H. H. Snelling Talks at Anthracite-Lehigh Valley

At the Easton meeting of the Anthracite-Lehigh Valley Section held on Jan. 26, H. H. Snelling, past vice-president of the A.S.M.E., discussed "The Rights of an Inventor-Employee." After outlining the general situation, Mr. Snelling emphasized that all terms used in the patent law must be clearly and accurately defined to avoid conflicting opinions on case decisions. He defined all terms by using apt illustrations of each and followed this with a discussion of oral, implied, and written contracts. A lively one-hour discussion followed.



BOSTON SECTION MEMBERS CELEBRATE THIRTIETH ANNIVERSARY AT DINNER, JANUARY 11, 1940

Boston Section Anniversary Meeting Attended by 282

The Thirtieth Anniversary of the organization meeting of the Boston Section was held at M.I.T. on Jan. 11. Dinner was served at 6:30 p.m. and at 7:30 p.m. a brief ceremony was held in observance of the anniversary. Prof. Edgar McNaughton, chairman of the Boston Section, called the meeting to order and introduced Percy C. Idell, who acted as toastmaster. Mr. Idell in turn introduced the members and guests at the head table, including J. C. Hunsaker, vice-president of the A.S.M.E., who brought greetings as a member of the Council of the Society, Charles T. Main, H. J. Brown, Prof. J. W. Zeller, R. A. Spence, secretary-treasurer of the Section, W. R. Boucher, Ralph E. Curtis, first secretary of the Section, and G. K. Saurwein, who read parts of the minutes of the first meeting held by the Section thirty years ago. Also introduced were all past-chairmen of the Section who were present.

Mr. Idell then called upon E. G. Bailey, the speaker of the evening, who presented a talk to the 282 present on "Thirty Years' Progress in Steam Boilers in New England." The paper was illustrated with lantern slides. Much credit for the success of the meeting was due to the work of the Boston Junior Group, E. I. Bower, chairman.

Radio Station Broadcasts Talk Before Bridgeport Section

On Friday, Jan. 26, Bridgeport Section in conjunction with the Engineers' Club of Bridgeport and the C.S.P.E., held a meeting at which Dr. Walter C. Lowdermilk, assistant chief, soil conservation service, U. S. Department of Agriculture, gave a talk on "Soil Erosion and Flood Control." This talk was broadcast over radio station WICC. Following this, Mayor Jasper McLevy of Bridgeport and Olcott F. King of the Connecticut Agricultural Department made some very interesting comments on the talk.

National Industrial Economy Discussed at Buffalo Meeting

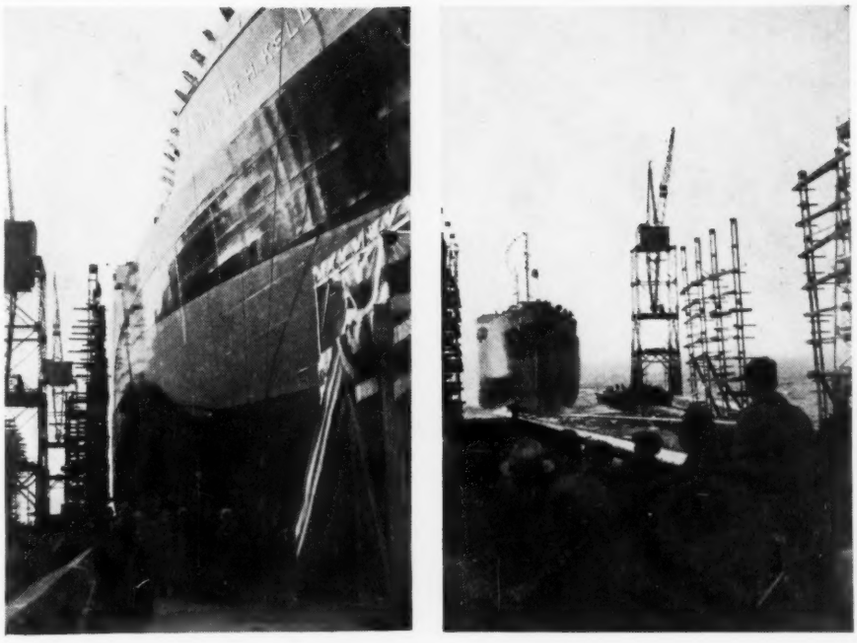
About 100 members and guests were present at the Jan. 16 meeting of the Buffalo Section to listen to a paper on "Some Operating Characteristics of the National Economy," which was presented by Prof. Walter Rautenstrauch of Columbia University.

Central Illinois Session Attracts 342 "Member-Years"

In writing about the Feb. 1 meeting of the Central Illinois Section, at which Harte Cooke was the principal speaker, Robert T. Mees, secretary-treasurer of the Section, estimates that the session attracted 342 A.S.M.E.-member-years, including Mr. Cooke's 43. Mr. Cooke did such a fine job on his paper about Diesel engines, that the Section members dubbed him with a new nickname, "Pinch-hitter" Cooke, since he was taking the place of President McBryde, who was originally scheduled to talk but could not make it because of illness.

Influence of Gasoline Engine on Life at Central Indiana

Centered around a survey prepared by Prof. H. M. Jacklin of the progress and influence of the internal-combustion engine on American life and living, the annual Purdue University meeting of the Central Indiana Section was held on Jan. 19. There were 35 members and 15 visitors present.



BALTIMORE SECTION MEMBERS VISIT SHIPYARD AND SEE LAUNCHING OF SHIP, JANUARY 6, 1940

Central Pennsylvania Hears Engineering Is Branch Only

Meeting with the local chapter of the Society for the Promotion of Engineering Education on Jan. 11, the Central Pennsylvania Section presented a talk by A. V. Karpan, consulting engineering of Pittsburgh, on "Engineering as a Branch." The paper dealt with the broad axioms and concepts of science; engineering was just a subdivision or branch of the whole.

250 Show up for Chicago Meeting to Hear Talk by A. E. Grunert

A. E. Grunert, superintendent of generating stations, Commonwealth Edison Co., gave a paper before 250 members and guests of the Chicago Section on Jan. 10. His paper covered the operating records, availability, performance, and other characteristics of topping unit No. 15 at the Fisk Station of his company. On Jan. 16, A. R. Walker told an audience of 40 about the differences between air conditioning of a stationary enclosure and a moving railroad passenger coach. Operating problems as they affect design were discussed.

Control of Unemployment Proposed at Cincinnati

Ralph E. Flanders, past-president of the A.S.M.E., was the guest speaker at the Jan. 25 meeting of the Cincinnati Section. More than 100 members and 50 guests heard Mr. Flanders present a 7-point program for the control of unemployment. He urged business to recover its courage and the government to remove the hurdles. According to him, it was up to the government to see that all who were able and willing to work should have a chance to do so.

Colorado Section Presents Session on Modelmaking

On Jan. 26, the Colorado Section presented a talk on modelmaking and instruments by A. W. Ainsworth. He showed an operating model of a New York Central locomotive built $^3/_4$ in. to the ft. Following this, he demonstrated various types of instruments and sensitive balances.

Detroit Holds Two Joint Meetings With Canadian Engineers

Once a year, the Detroit Section holds a joint meeting with the Border Cities Branch of the Engineering Institute of Canada. This year, the affair was held on Jan. 12 and included a visit to a whiskey distillery in Windsor in the afternoon and a dinner meeting in the evening at which time, Henry G. Weaver, General Motors Corp., talked on "Sampling Public Opinion." There were 175 present at this meeting. Then, on Jan. 21, the Detroit Section acted as hosts to the Canadians by inviting them to join with the Detroit members and wives as guests of the Ford Motor Company at the regular Sunday one-hour broadcast.

A. G. CHRISTIE, L. A. COFFIN, AND C. R. CHISHOLM

(Past-President Christie examines silver letter opener presented him by Mr. Coffin at the dinner meeting of the Baltimore Section on January 10.)

Air Transportation Topic at East Tennessee Meeting

"Air transportation has come of age" was the statement made by Ralph S. Damon, vice-president, American Airlines, Inc., at the Jan. 19 meeting of the East Tennessee Section which was attended by 73 members and guests.

THE MANY INSPECTION TRIPS, PLANNED BY ACTIVE COMMITTEE MEMBERS, ARE ALWAYS INTERESTING
(Shown here are two groups which visited the Westinghouse plant during the 60th
the Semi-Annual Meeting in Milwaukee, Wis., will also

Stainless Steel Discussed Before Fort Wayne Section

Following a dinner on Jan. 5, Mr. Lichtenwaller and Mr. Hughes of the Republic Steel Corp. gave a paper on "Stainless Steel—Its Metallurgy and Application," before the Fort Wayne Section.

Industrial Mobilization Is Subject at Los Angeles

More than 125 members and guests of Los Angeles Section were present at the Jan. 11 meeting devoted to industrial mobilization. The speakers were Maj. J. L. Stromme, Air Corps, U. S. Army, and Maj. A. B. Baird, Ordnance Dept., U. S. Army.

A.S.M.E. Calendar

of Coming Meetings

May 1–3, 1940
Spring Meeting
Worcester, Mass.

June 17–20, 1940
Semi-Annual Meeting
Milwaukee, Wis.

June 19–22, 1940
Oil and Gas Power Division
Asbury Park, N. J.

June 20–21, 1940
Applied Mechanics Division
Ann Arbor, Mich.

September 3–6, 1940
Fall Meeting
Spokane, Wash.

December 2–5, 1940
Annual Meeting
New York, N. Y.

(*For coming meetings of other organizations see page 18 of the advertising section of this issue*)

Metropolitan Section Presents Several Interesting Meetings

Several hundred members and guests attended meetings of the Metropolitan Section in January. On Jan. 11, about 200 were present to hear a talk on inclined railways and blast-furnace ore hoists given by C. T. Spriggs and Stanley W. Burriss, both of the Otis Elevator Company. On Jan. 31, another 200 interested in the aims and objectives of management came to listen to an interesting talk on the subject by Howard Coonley, chairman of the board, National Association of Manufacturers.

New Orleans Section Joins in Annual Meeting of L.E.S.

As part of the annual two-day meeting of the Louisiana Engineering Society, Jan. 12–13, the New Orleans Section held a meeting on Jan. 12 in the morning at which A. M. Lockett delivered a talk on "Engineering Applied to Business Management." K. P. Kammer, chairman of the Section, presided.

North Texas Has Joint Meeting With A.I.E.E. on Jan. 29

At the annual joint A.S.M.E.-A.I.E.E. meeting on Jan. 29, the North Texas Section members heard an interesting paper on the aqueduct between Parker Dam and the Los Angeles basin. It was given by Dr. William Monroe White, hydraulic engineer, Allis-Chalmers Mfg. Co.

336 Attend Philadelphia Meeting on Plastics

Following a dinner on Jan. 23 which was attended by 118 members and guests, a sound colored motion picture, "Modern Plastics Preferred," was shown. After that, Gordon Brown, Bakelite Corp., talking on "Plastics," outlined for the 336 present the history of the many products known as plastics and traced the development to the present. The discussers were Willard F. Bartoe, J. A. Silver, and F. L. Creager. At the close of the meeting, much interest was shown in the many exhibits of plastic materials which were supplied by various companies.

Surface Lapping Discussed at Norwich Section Meeting

Development of lapping machinery was described and illustrated with sound motion pictures before the Norwich Section on Jan. 24 by H. S. Indge, engineer, Norton Company.

Process of Flame Hardening Described at Oregon Section

Following a dinner on Jan. 26, members of Oregon Section learned all about the process of flame hardening from H. E. Spieth, Western Steel Casting Co., and Prof. S. H. Graf, Oregon State College.

Rochester Sees Motion Picture Film on Copper

"Copper from Mine to Market" was the title of the motion picture presented at the Jan. 18 meeting of the Rochester Section after a talk on the same subject by A. H. Dodge, Copper Products Corp. More than 100 members and guests were present.

Rock River Valley Hears Minerals Key to Peace

Dr. C. K. Leith told the members of Rock River Valley Section on Jan. 18 that if the allies maintain the status quo in the present war, the war will be of short duration because Germany has a shortage of all kinds of raw materials, including iron, oil, and copper which are very important for the success of modern warfare.

Nonferrous Alloys Topic at St. Louis Meeting

Albert Vigne, vice-chairman of the St. Louis Section, was the speaker on Jan. 26 on the sub-

FEATURES OF LOCAL AND NATIONAL MEETINGS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Annual Meeting in Philadelphia. The Spring Meeting in Worcester, Mass., and offer an extensive list of industrial plant inspection trips.)

ject of "Nonferrous Alloys." He traced the history of the industry from early times to the present and then discussed the many problems encountered in the manufacture and application of the alloys.

San Francisco Members Hold Interesting Railroad Session

At the Jan. 25 meeting of the San Francisco Section, the program was devoted to the subject of railroads. Prof. Stuart Daggett, University of California, gave a paper on "History of Rail Transportation," in which he brought out many interesting sidelights about railroading in the United States. "The Modern Trend in the Design of Railway Trains" was the title of a paper prepared by E. J. W. Ragsdale and read by Hal Curtis, Edw. G. Budd Mfg. Co.

Susquehanna Welcomes Past-President Christie

After an enthusiastic welcome on the part of the members of the Susquehanna Section meeting in York, Pa., on Jan. 16, Prof. Alexander G. Christie gave a paper on "Creative Engineering," and illustrated it with actual samples of some of the present-day products made possible by it.

Utah Coal Discussed by Members of Utah Section

Following a film on the mining and preparation of Utah coal, members of the Utah Section discussed the various possibilities of the coal during the meeting held on Jan. 31 in Salt Lake City.

Worcester Section Looks Into Future of Engineering

Members and guests of Worcester Section numbering 85 were present on Jan. 11 to hear all about the "Future of Engineering" as revealed by Dean Dexter S. Kimball, past-president of the A.S.M.E.

1940 A.S.M.E. Membership List Mailed in February to All Members

THE 1940 A.S.M.E. Membership List, which is Section Two of the February Transactions, has been mailed to all members of The American Society of Mechanical Engineers entitled to receive publications. Those who regularly receive Transactions will find the Membership List in the same envelope with Section One, and others will receive it as a special mailing from the New York office.

In accordance with a new rule governing the distribution of the Membership List, approved by the Committee on Publications and by the Council, only one copy of the Membership List will be furnished members without charge. If a member fails to receive a copy he should report it prior to April 20 in order to obtain a free copy. The charge for copies furnished after that date, or for extra copies, will be ($1.50) each. It will not be sold to nonmembers of the Society.

Copies of the Membership List will be found in the regular depositories for the Transactions in this country and abroad, including the Student Branch libraries. Complimentary copies are also distributed to societies engaged in joint activities with the A.S.M.E. and to other societies which exchange such publications, as well as to certain other organizations approved by the Publications Committee.

Members of the Society are urged to observe the restrictions given on the inside back cover of the Membership List, as follows:

> "The Membership List is issued for the personal use of members of The American Society of Mechanical Engineers in connection with Society and professional affairs. Each member is expected to conserve it and not to permit his copy to be used for the basis of circularization. Such use is annoying to fellow members."

B. F. Stangland Receives 50-Year A.S.M.E. Badge on 92nd Birthday

THE developer of the idea of using delicate scales for counting small parts in factories, B. F. Stangland, was presented with a 50-year A.S.M.E. badge on Jan. 20, which was also his 92nd birthday. The actual presentation was made for the Society by Mr. Stangland's daughter, Mrs. Jessie Cary Grange, at his home in Kendall, N. Y.

He was the Fairbanks Scale Co. representative in Chicago when the great fire occurred in 1871. When young Stangland saw that the office district was doomed, he loaded all his firm's books on a hand truck and wheeled them to safety. In 1876, he had charge of the company's exhibit at the Philadelphia Exposition. From 1879 to 1916, when he retired, Mr. Stangland was development engineer for a ventilator fan company in New York City and in this capacity designed many of the fans for some of the largest buildings of his time.

Registration Fee for Non-Members at the 1940 Spring Meeting

There will be a registration fee of $2 for nonmembers attending the 1940 A.S.M.E. Spring Meeting. For nonmembers wishing to attend just one session the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests may avoid this fee by writing to the Secretary of the Society before April 23 asking for a guest-attendance card for the Annual Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member*.

Junior Group Activities

Baltimore Juniors Arrange Meeting on Job Analysis

MORE than 100 members of the Baltimore Section were present on Jan. 10 at a meeting arranged and conducted by the Baltimore Junior Group. Thomas W. Mele, Junior A.S.M.E., and engineer with the Fisher Body Co., talked on "Improved Shop Operation Through Job Analysis." His talk concerned the efficiency of an operator and the technique used to improve shop operations. A demonstrator at a work bench showed how the scientific principles of efficiency can be incorporated in the job. Slides and motion pictures were then shown.

Philadelphia Juniors Hold Meeting-Inspection Trip

THE Golden Gate Bridge at San Francisco was the subject of the monthly meeting of the Philadelphia Junior Group on Jan. 10. One of the construction engineers who was on the job for John A. Roebling's Sons Company described the spinning of the cable and the preliminary work that was involved. There were many unique details and many engineering problems had to be solved. After the description, a sound movie was shown of the work actually in progress. The magnitude of the task was really stupendous, and it was not surprising that the movie brought forth many exclamations of surprise and wonderment.

A trip was conducted the following week to the Schuylkill Station of the Philadelphia Electric Company. This station is particularly interesting because of its two high-pressure boilers, with a working pressure of 1250 psi, and its topping turbine which generates 50,000 kva. The recent trend in the superposition of public-utility generating stations is nicely exemplified here.

Tri-Cities Juniors Conduct Session on Research in Industry

MEETING on Feb. 1 in Moline, Ill., the Tri-Cities Junior Group presented a program based on the topic, "The Place of the Research Laboratory in Modern Industry." The speaker was A. C. Hansen, engineer in the Rock Island Arsenal, War Department.

A.S.M.E. Juniors Honored for Work in Aviation and in Steam

TWO A.S.M.E. Juniors were honored during January for outstanding work in their particular fields. They are Charles M. Kearns, Jr., research engineer, Hamilton Standard Propellers Division of United Aircraft Corporation, and John I. Yellott, assistant professor of mechanical engineering at Stevens Institute of Technology.

Mr. Kearns received the Lawrence Sperry Award of 1939 from the Institute of the Aeronautical Sciences on Jan. 26 for his contribution to the advancement of aeronautics through his development of a method to measure the actual changes in a propeller blade under every flight condition. Already the method has been extended to studies of vibration in the engine and other parts of the airplane. This vibration indicator developed by Mr. Kearns has been hailed by aeronautical engineers as a distinct contribution to safety in the air.

Professor Yellott has taught steam power, thermodynamics, and heat transfer at Stevens and conducted research mainly in the field of high-velocity steam and air flow. He has been appointed professor and director of mechanical engineering at Armour Institute of Technology, effective as of the first of September, 1940, which is concurrent with the beginning of operation of Illinois Institute of Technology, the new school brought about by the merger of Armour and Lewis Institute. At the 1939 Annual Meeting of the A.S.M.E., he received the Pi Tau Sigma Award as the "outstanding young mechanical engineer of the year."

San Francisco Juniors Discuss Machinery and Job Getting

SAN FRANCISCO Juniors met on Dec. 14, to hear R. L. O'Bryan, Pacific Gas and Electric Company, present a paper on "Synchronous Machinery Reactance." Mr. O'Bryan pointed out the importance of a clear understanding of the subject to all engineers concerned with testing or design of electrical machinery. Since a large number of mechanical engineers are engaged in such work, a detailed analysis of the subject was quite appropriate for presentation to the A.S.M.E. Group.

For the Jan. 18 meeting the Group held a round-table discussion on "Personnel and Management." The Group was pleased to have as guests for the evening George Raitt, manager of the Steel Tank and Pipe Company of California, and chairman of the San Francisco Section, Dean G. L. Sullivan, a group of student members from Santa Clara University, and N. D. Cook, manager of the San Francisco office of the Engineering Societies Employment Service.

To open the session, C. L. Thorpe of Shell Development Company presented a paper on "Why Engineers Lose Jobs." He cited results of statistical investigations made in recent years of the problem of loss of jobs by technical employees. The general conclusion was that lack of technical ability was responsible in somewhat less than 10 per cent of the cases investigated. Called upon for some remarks on management, Mr. Raitt spoke of the great opportunities in industrial management for mechanical engineers who, he believed, were best-fitted of all industrial employees for this function.

Concerning the methods of obtaining jobs and promotions, Mr. Cook referred to his familiar formula: $P = \frac{I \times S}{D^2}$. He explained that P may be "pull" or "politics" or "promotion," while I is the intelligence possessed and brought to bear on the situation by the person concerned, S is the person's estimate of the demands of the situation or job specification, and D is the distance between the person and the situation, the job, or the man to be influenced. While D is usually considered to be spatial distance, it may also be the less tangible distance determined by lack of common ground of understanding or interest.

STUDENT MEMBERS OF UNIVERSITY OF NEVADA IN THE POWER LABORATORY
(Cerebus is the name of the dog which belongs to Dean F. H. Sibley.)

STUDENT MEMBERS, UNIVERSITY OF ILLINOIS

With the Student Branches

Many Large Companies Already Signing up June Graduates in Schools Throughout Land

Deans of Engineering Schools Estimate That Industrial Enrollment Is 300 Per Cent Ahead This Year

PROSPECTS of immediate jobs for the 1940 class of college graduates are the best in ten years according to "talent scouts" of General Electric Co., Westinghouse Electric & Manufacturing Co., Allis-Chalmers Manufacturing Co., E. I. du Pont de Nemours Co., and other large industrial concerns. Increased enrollment by individual companies, as well as the greater number of firms now canvassing the schools means a wider choice of positions for June graduates. Deans of engineering schools estimate that industrial enrollment of students is now running as much as 300 per cent ahead of the same period last year.

Walter Geist, vice-president and head of graduate training of Allis-Chalmers Mfg. Co., states that the points that he and other "scouts" base their selections on are a student's record in classes, his appearance and personality, and character and mentality as revealed by professors, classmates, and friends. Both Mr. Geist and A. R. Stevenson, Jr., of the General Electric Co., say that many mechanical engineers coming to their companies eventually shift to electrical-engineering work and electrical engineers become mechanical engineers.

A. H. Meyer, secretary of the Engineering Societies Employment Service, which is a cooperative enterprise of the four Founder Societies, reports that about 85 to 90 per cent of the 1939 graduates were placed before October of last year. He says that the percentage will be much higher this year.

Branch Meetings

Speaker Is Armour Graduate

A JOINT MEETING of the ARMOUR BRANCH of the A.S.M.E. and the student chapter of the W.S.E. was held on Jan. 5. The speaker was an Armour graduate, W. E. Rietz, Powers Regulator Co., who talked to the 100 students present about "Engineering Personnel." At the Jan. 19 meeting of the Branch, 60 members saw and heard a sound motion picture on the manufacture, test, and operation of Diesel engines. Following the showing, Edmund Francone gave a paper on "Research in Engineering."

CALIFORNIA BRANCH started its Jan. 25 meeting by having the 55 members and 20 visitors present sing some school songs under the direction of Jim Dinsmore. Following this, Robert Sibley, member A.S.M.E. and past-chairman of the San Francisco Section, addressed the group on the aims and activities of the Society.

COLORADO BRANCH had Mr. Nation, National Tube Co., as the speaker on Jan. 10, and Mr. Throne, Public Service Company of Denver, as the talker on Jan. 23.

COLORADO STATE BRANCH met on Jan. 29 and discussed plans for Engineers' Day on Mar. 23 at which the Branch will have a special exhibit. Then Mr. Davis, of the Lane-Wells Co., presented a motion picture on modern oil-well drilling.

New Cornell Engineering Council

President Edmund E. Day of CORNELL UNIVERSITY recently announced that the new Engineering College Council has as its members, besides Dean S. C. Hollister and himself, ex officio, James W. Parker, vice-president A.S.M.E., J. Carlton Ward, Jr., member A.S.M.E., Thomas Midgley, Jr., Harold W. Elley, J. C. Wilson, member A.S.M.E., O. E. Buckley, chairman of Engineering Foundation, Alexander W. Dann, F. W. Scheidenhelm, and Walker L. Cisler, member A.S.M.E. The Council will study the work of the College of Engineering, advise the administration, with regard to policies and programs, and aid in other ways.

COOPER UNION BRANCH (evening) started off the competition for a prize of $5 by having the chairman of the Branch present the first paper in the contest at the meeting of Feb. 2. His paper dealt with tunnel construction and was aptly entitled "Holes."

IDAHO BRANCH held its first meeting of 1940 on Jan. 11 with 19 members present. One member from each class was selected to act as coordinator in planning and assembling material for the Engineers' Show to be held next May.

Harte Cooke at Iowa State

IOWA STATE UNIVERSITY BRANCH had meetings on Jan. 10 and 17 at which papers were presented by student members. The speakers were J. Bielenberg, J. L. Wilson, W. Jackson, Paul Keyes, and Jens Norgard.

Diesel engines were discussed at the Jan.

STUDENT MEMBERS OF GEORGE WASHINGTON UNIVERSITY POSE FOR PICTURE, JANUARY 10, 1940

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
1940 STUDENT MEETINGS

	Group	*Host*	*Place*	*Dates*	*Representative of Committee on Relations With Colleges*
I	New England	Worcester Poly. Institute	Worcester, Mass.	May 3–4	A. C. Chick
II	Eastern	Newark College of Engineering	Newark, N. J.	April 29–30	P. B. Eaton
III	Alleghenies	University of Maryland	College Park, Md.	April 25–26	P. B. Eaton
IV	Southern	Birmingham Section	Birmingham, Ala.	April 1–2	E. W. O'Brien
V	Midwest	Armour Institute of Technology	Chicago, Ill.	April 15–16	J. D. Cunningham
VI	North Central	University of Kansas	Kansas City, Mo.	April 26–27	H. O. Croft
VII	Southwest	Texas Technological College	Lubbock, Texas	April 19–20	E. W. O'Brien H. E. Degler
VIII	Pacific Northwest	State College of Washington University of Idaho	Pullman, Wash. Moscow, Idaho	April 28– May 1	E. O. Eastwood
IX	Rocky Mountain	University of Utah	Salt Lake City, Utah	April 19–20	H. O. Croft
X	Pacific Southwest	University of Santa Clara	Santa Clara, Calif.	March 29–30	G. L. Sullivan

31 session of the IOWA STATE COLLEGE BRANCH which was attended by 73. Harte Cooke, representing the Society, was the speaker.

ILLINOIS BRANCH had as guest speaker on Jan. 10, C. H. Kraus, chief research engineer, Ingersoll Milling Machine Co., who spoke on "Design of Special Machine Tools." More than 100 student members were present.

KANSAS BRANCH devoted its meetings on the 9th and 18th of January to papers on welding. At the first meeting, M. Yost, Linde Air Products Co., described a new electric-welding process developed by his company and showed motion pictures on flame hardening. Mr. Singleton, the speaker at the second meeting, spoke on the subject of "Modern Developments in Welded-Steel Structures."

LAFAYETTE BRANCH had an interesting, as well as profitable, meeting on Jan. 10 when a representative of the A. M. Byers Wrought Iron Pipe Co., gave a motion-picture show to all and handbooks on wrought iron to the seniors.

125 at Louisville Meeting

More than 125 members and guests of LOUISVILLE BRANCH turned out on Jan. 18 to hear Maxwell C. Maxwell talk on materials handling. Every one thought that the paper was very instructive and entertaining.

MICHIGAN BRANCH held its meeting of Jan. 10 jointly with the S.A.E. student chapter. The guests for the evening were Dr. J. J. Bloomfield, of the U. S. Health Service, and Dr. F. Selby, medical director of General Motors. Dr. Bloomfield addressed the meeting on "Engineering Aspects of Occupational Diseases."

MINNESOTA BRANCH held a dance on Jan. 26 in Minneapolis for the benefit of the fund for the new mechanical-engineering building. A campus band led by a student member furnished the music.

MISSOURI SCHOOL OF MINES BRANCH at its meeting of Jan. 24 had L. L. Wilson, Ethyl Corp., present a motion picture on fuels and give a demonstration with a test engine.

Newark Has Graduate for Speaker

Robert Ward, graduate of 1938, was the guest speaker at the Jan. 22 meeting of the NEWARK BRANCH. Based on his work with the Eclipse Aviation Co., the speaker talked on "Aircraft Steels and a Metallurgist's Part in the Aircraft Industry."

NORTH DAKOTA BRANCH had the following student members speak at the Jan. 10 and Feb. 7 meetings: Tom Strand, Lyle Stayner, F. L. Svore, and Stanley Voak.

NORTH DAKOTA STATE BRANCH members made an inspection trip on Jan. 10 to the machine shop of the Fargo Foundry. The various machines in the shop were demonstrated.

NORTHWESTERN UNIVERSITY announces the appointment of Ferdinand G. Seulberger as professor of cooperative education and director of industrial relations in the Technological Institute. He will run the cooperative course in the school by which students will alternate between classroom study and industrial jobs on a three-months' basis.

NOTRE DAME BRANCH heard a talk on Jan. 19 by Russell King, student member, on "Journal Packings."

MEMBERS OF THE STUDENT BRANCH AT UNIVERSITY OF NOTRE DAME

War and Minerals at Ohio

John D. Sullivan, chief chemist, Battelle Memorial Institute, spoke before the OHIO STATE BRANCH on Jan. 12 on the general topic of some of the mineral resources of the world, particularly those which are significant in time of war. His talk was illustrated with slides showing the distribution of ores and minerals among the various countries of the world.

OKLAHOMA BRANCH has invited the members of the Mid-Continent Section to the meeting to be held on Feb. 29.

PURDUE BRANCH at its meeting of Jan. 11 showed a narrative motion picture entitled "Copper, From Mine to Market." More than 50 members attended.

SANTA CLARA BRANCH members met on Jan. 17 and heard two excellent papers which were delivered by Eugene Stephens, on "Liquefaction of Gases," and by Ernest Cambou, on "The Hydromatic Clutch." The meeting was closed with coffee and doughnuts.

Rose Technic Is Active

At the Jan. 18 meeting of ROSE TECHNIC BRANCH talks were given by two student members. Maurice Fleming spoke on "Ejectors," and Allen Wilson on "Hydraulic Transmissions." On Jan. 19, several of the student members motored to Lafayette, Ind., to attend the Central Indiana Section meeting at PURDUE UNIVERSITY.

TEXAS A.&M. BRANCH opened its meeting with a short motion picture starring Sonja Henie. Then, Bob Nalley, B. Hutchins, J. J. Walker, and W. Trail gave short talks on the 1940 automobiles.

TEXAS BRANCH heard W. E. Seaholm, city engineer of Austin, Texas, on Dec. 12, describe the Colorado River Authority and its work. Particularly interesting were the construction details of the Tom Miller Dam,

Marshall Ford Dam, Inks Dam, and Buchanan Dam, all of which are within a 75-mile radius of Austin.

Secrecy Reigns at Toronto

After a fine paper on "Production of Airplanes at Malton, Ontario's Wartime Aircraft Plant," which was given by B. J. Elkin at the Jan. 23 meeting of the TORONTO BRANCH, certain questions by student members remained unanswered because they were government secrets. Three other papers by students on the subject of aviation followed.

VANDERBILT BRANCH now has a record membership of 35, the largest number in its history, according to a report presented by C. Darby Fulton, secretary, at the meeting on Jan. 31.

VILLANOVA BRANCH had Maxwell C. Maxwell as the guest speaker on Jan. 3. His topic was "Materials Handling." On Jan. 6, an inspection trip was made to the Conowingo hydroelectric plant of the Philadelphia Electric Co.

VIRGINIA BRANCH transacted a great deal of business at its Jan. 23 meeting.

George Washington's New Dean

Frederick M. Feiker, member A.S.M.E. and executive secretary of A.E.C., assumed his duties as dean of the engineering school of GEORGE WASHINGTON UNIVERSITY the beginning of February. On Feb. 14, under the sponsorship of the A.S.M.E. Student Branch, all engineering students attended a reception in honor of the new dean.

WASHINGTON BRANCH had 55 present at its meeting on Jan. 11 at which Otis Lamson, student member, discussed his experiences during last summer in the Buick automobile plant. At the same time, plans were made for Engineers' Open House, an annual function of the school of engineering.

LAST CALL!!!

All reports and photographs from Student Branches for insertion in the May issue of MECHANICAL ENGINEERING, which is the last copy to be received by student members for the school year 1939–1940, must be received at A.S.M.E. Headquarters not later than April 6. Anything received after that date cannot be used.

A.S.M.E. Semi-Annual Meeting

Milwaukee, Wis., June 17–20

Milwaukee, the birthplace of the Local Sections movement in The American Society of Mechanical Engineers, will be the host for the 1940 Semi-Annual Meeting of the Society, June 17–20. Meeting headquarters will be in the Hotel Pfister. Events scheduled include 21 technical sessions, an S.P.E.E. luncheon, plant visits to a dozen or more industrial plants, business meeting, dinner, and a smoker at one of the city's famous breweries.

A.S.M.E. Woman's Auxiliary Adopts Section Rules

THE National Board of the Woman's Auxiliary to the A.S.M.E. convened on Feb. 8 in the Society's rooms at the Engineering Societies Building. Mrs. George W. Farny, president, presided and the rules for the organization of Local Sections were adopted. Mrs. G. E. Hagemann, chairman of the membership committee, reported a membership of 249 in good standing. Mrs. A. H. Morgan, treasurer, announced a contribution from the Cleveland Section of $25 for the Educational Loan Fund, and Mrs. G. L. Knight, Sponsor for the Philadelphia Section, noted a pledge of $25 for the Calvin Rice Scholarship Fund. It was voted to invite the wife of the president of the A.S.M.E. to become an honorary member during his term of office.

Members of the National Board of the Auxiliary for 1940, besides the elected officials, consist of the following committee chairmen: Ways and Means, Mrs. A. R. Cullimore; Educational Loan Fund, Mrs. R. V. Wright; Hospitality, Mrs. R. S. Austin; Publicity, Miss Burtie Haar; Membership, Mrs. G. E. Hagemann; Custodian, Miss Burtie Haar; Calvin Rice Memorial Fund, Mrs. J. Ansel Brooks; and Editor of News-Letter, Mrs. R. F. Gagg. Sponsors of various Local Sections include Mrs. A. Kingsbury, Baltimore; Mrs. V. M. Frost, Cleveland; Mrs. C. Field, Los Angeles; and Mrs. G. L. Knight, Philadelphia.

The Board adjourned to meet with the members of the Metropolitan Section for luncheon at the Engineering Woman's Club. Later, all members visited the Ajello Candle Co. The beauty and unique designs of the candles were impressive.

A.S.T.M. Spring Meeting in Detroit, Mich., March 6

A SYMPOSIUM on new materials in transportation, comprising six technical papers, will be the technical feature of the 1940 spring meeting of the American Society for Testing Materials to be held at the Hotel Statler, Detroit, Mich., on Wednesday, Mar. 6.

Throughout the week beginning on Monday, Mar. 4, extending through Friday, Mar. 8, there will be in progress the spring meetings of various A.S.T.M. committees. Main business of the committees will be the review of their research and standardization projects under way and the development of recommendations which will be included in reports to be presented at the annual meeting of the A.S.T.M.

Greater New York Safety Convention, Apr. 16–18

COOPERATING in the 11th Annual Greater New York Safety Convention, which is to be held at the Hotel Pennsylvania, Apr. 16–18, is the A.S.M.E. This convention will embrace 42 sessions at which 175 prominent speakers will deliver papers on industrial, commercial, and mercantile safety and accident-prevention subjects. The topics that will be discussed should be of great interest to many an A.S.M.E. member and include pressure vessels, materials handling, aeronautical safety and personnel. Additional information may be obtained by writing to the Greater New York Safety Council, Inc., 60 East 42nd St., New York, N. Y.

U. S. Supreme Court Denies Parker Writ of Certiorari

In the November, 1939, issue of MECHANICAL ENGINEERING, page 847, President Christie presented a brief summary of the Parker Case up to Oct. 12, 1939, when the Court of Appeals of the State of New York refused to grant Mr. John Clinton Parker the privilege of re-arguing the case. Since that date Mr. Parker petitioned the Supreme Court of the United States for a writ of certiorari. Denial of this petition by the Court was announced on February 5, 1940, "for the reason that the Court, upon examination of the papers herein submitted, finds no grounds upon which a writ of certiorari should be issued."

A.I.E.E. Nominates Officers for 1940–1941

FOR the offices becoming vacant Aug. 1, 1940, the national nominating committee of the American Institute of Electrical Engineers has nominated the following engineers: President, Prof. R. W. Sorenson; vice-presidents, Everett S. Lee, member A.S.M.E., Dean J. W. Barker, member A.S.M.E., K. L. Hansen, J. L. Hamilton, and A. LeRoy Taylor; directors, T. F. Barton, M. S. Coover, and R. G. Warner; and treasurer, W. I. Slichter, member A.S.M.E.

A.S.M.E. to Be Represented at Social Science Meeting

PRESIDENT Warren H. McBryde has appointed three members of the A.S.M.E. to represent the Society at the forty-fourth annual meeting of The American Academy of Political and Social Science to be held in Philadelphia, Apr. 12–13, 1940. The representatives are E. L. Hopping, Philadelphia Electric Co., Prof. L. N. Gulick, University of Pennsylvania, and L. P. Hynes, consulting engineer.

Instrumentation Conference, Camden, N. J., Mar. 12–14

A THREE-DAY conference and exhibit will be held Mar. 12–14, 1940, in the gymnasium of the Camden Vocational School, Camden, N. J., under the sponsorship of the Power Maintenance Association of South Jersey. The exhibit by leading instrument manufacturers will show the proper use of instruments to enable industry to minimize production, processing, and operating costs.

Public and Industry Will Profit by Revised Table on Boiler Tubes

AN ADDENDUM is soon to be made to the A.S.M.E. Boiler Code in the form of a modified Table P-2, "Gages of Tubes for Water-Tube Boilers," which was adopted by the Society's Boiler Code Committee at its Dec. 1, 1939, meeting after more than three years of hearings at which careful consideration was given to results of tests, criticisms, and suggestions, in order to benefit industry and to protect the public. The revised table, published in the January, 1940, issue of MECHANICAL ENGINEERING for final criticism, is now to be issued.

Since the issuance of the original edition of the A.S.M.E. Boiler Code in 1914, the tabulations of maximum allowable working pressures for seamless and lap-welded steel up to 875 lb per sq in. and boiler wrought-iron tubes or nipples up to 350 lb per sq in. in Tables P-2 and P-3 have been the guide of the boiler industry for the safe construction of water-tube boilers. During the last few years there have been remarkable developments in the construction of water-tube boilers leading to increased pressures of as much as 2500 lb per sq in. in a few cases, and 1400 and 1500 lb per sq in. in most installations. In view of the extremely high temperatures encountered with such high working pressures, it soon became apparent that there was need of thinner tubes and also of other types of tubes.

Accordingly, the Boiler Code Committee focused attention on a revision of the two tables to provide more adequately for the increased and more severe requirements. Several revisions, based on theoretical considerations, the correctness of which had been checked by laboratory and service data, to provide for lighter gages of tubes for water-tube boilers were proposed and submitted to the Committee. In these recommendations distinctions were made between seamless tubes and tubes welded by the lap-forging process and the electric-resistance welding method. Because so many tubes had been fabricated by the latter process and proved successful in industry, protests were received against making any material distinction between them and the other types of tubes. Keeping in mind its responsibilities to the public and its safety, the Boiler Code Committee appointed a special subcommittee to make a thorough study of the situation.

Based on the findings of the subcommittee, several hearings were held by the Boiler Code Committee in order to give representatives of manufacturers of the various types of tubes an opportunity to consider the proposed changes and to make recommendations. Finally, the revised table, now to be issued, was adopted by the Committee at its December meeting.

That this very important problem was solved successfully can be judged best from the following resolution adopted at the Jan. 13 meeting of the Executive Committee of Council: "Voted: To express to the Boiler Code Committee its sincere gratification and satisfaction at the splendid manner in which the controversy on gages of tubes for water-tube boilers was resolved."

Fluid Metering Conference, Norman, Okla., Apr. 11–12

THE preliminary program for the Petroleum Fluid Metering Conference has been completed by the general committee which is under the chairmanship of Dean W. H. Carson. Scheduled to be held at the University of Oklahoma, Norman, Okla., April 11–12, 1940, this year's Conference is again under the joint sponsorship of the Petroleum Division and Mid-Continent Section of the A.S.M.E. and the College of Engineering at the University. Additional information may be obtained from the secretary of the Petroleum Division, William J. Overton, 211 Midco Building, Tulsa, Okla.

The tentative program in detail, follows:

THURSDAY, APR. 11

8:00 a.m.

Registration. Engineering Building

10:45 a.m.

Welcome by Dean W. H. Carson

11:00 a.m.

Technical Session

Viscosity and Its Effect on the Accuracy of Positive Displacement Metering, by J. W. Donnell, University of Oklahoma

Fundamental Principles of Volume Meters, by E. E. Ambrosius, University of Oklahoma.

1:00 p.m.

Luncheon recess

2:00 p.m.

Technical Session

Some Fundamental Considerations in the Design and Application of Displacement Meters, by E. W. Jacobson, Gulf Research and Development Company

Crude Production Measurement, by E. O. Bennett, Continental Oil Company

FRIDAY, APR. 12

9:00 a.m.

Technical Session

Problems Encountered in Distillate Measurement, by Earl Kightlinger, Arkansas-Louisiana Gas Company

Calibration of Meters in Pipe-Line Service, by Henry Pohl and E. H. Counts, Sinclair Prairie Pipe Line Company

Progress Report on Fluid-Metering Research at University of Oklahoma, by E. E. Ambrosius, University staff member, and H. S. Bean, U. S. Bureau of Standards

Progress in the Use of Meters in Crude Pipe-Line Service, by T. R. Aude, Stanolind Pipe Line Co.

1:00 p.m. Luncheon recess

2:00 p.m.

Technical Session

Displacement Meters in the Refinery, by W. H. McCoy, Gulf Refining Co.

Committee Adopts Definitions for Instruments

DEFINITIONS for industrial instruments, which were prepared by a subcommittee, were adopted at a recent meeting of the A.S.M.E. Committee on Industrial Instruments and Regulators. A list of the terms and their definitions follows:

An *automatic controller* or *regulator* is an apparatus which measures the value of a quantity or condition which is subject to change with time, and operates to maintain within limits this measured volume.

An *automatic control (regulation) system* consists of two or more interconnected automatic controllers (regulators) acting together to maintain with limits the value of a single designated variable.

The *controlled variable* is that quantity or condition which is measured and controlled by the automatic controller (regulator).

A *control agent* is a medium in a process which is varied by the automatic controller (regulator) and which affects the value of a variable.

The *throttling range* is that range of values through which the variable must vary to cause the final control (regulating) element to move from one extreme position to the other. It may also be expressed as a percentage of the range of the instrument.

The *set point* is that value of the variable which it is desired to maintain.

The *deviation* is the difference at any time between the value of the controlled variable and the set point.

The *measuring means* of a controller (regulator) consists of those elements which are involved in ascertaining and communicating to the controlling (governing) means an indication of the magnitude of the controlled variable.

The *controlling (governing) means* of an automatic controller (regulator) consists of those elements which, acting together, produce corrective action based upon indications supplied by the measuring means.

The *final control (regulating) element* is that portion of the controlling (governing) means which directly varies a control agent.

John H. Keyes Receives Youth Organization Award

AT THE annual meeting of the Tulsa Council of Boy Scouts on Jan. 23, John H. Keyes, member A.S.M.E. and chairman of the membership committee of the Mid-Continent Section, received the highest award of the national organization, the "Silver Beaver," for outstanding service to American boyhood. Mr. Keyes has been actively interested in the boy-scout movement since 1931.

Consulting Engineers Elect New Officer

AT a meeting of the Council of the American Institute of Consulting Engineers, held in New York City Jan. 16, 1940, the following officers were elected: President and secretary, Philip W. Henry; vice-president, Ole Singstad; and treasurer, James Forgie.

J. H. Doolittle, Member of A.S.M.E., Elected President of the I.Ae.S.

AT the annual meeting of the Institute of the Aeronautical Sciences held at Columbia University, New York City, on Jan. 24, announcement was made of the election of Major James H. Doolittle, member A.S.M.E., as president to succeed Dr. George W. Lewis. The other officers elected for 1940 were the following as vice-presidents: W. A. M. Burden, National Aviation Corp.; Sherman M. Fairchild, member A.S.M.E. and chairman of the board of Fairchild Aviation Corp.; R. H. Fleet, Consolidated Aircraft Corp.; H. J. E. Reid, N.A.C.A. Major Lester D. Gardner, member A.S.M.E., was elected executive vice-president, Leroy R. Grumman, Grumman Aircraft Engineering Corp., treasurer, and C. E. Sinclair, secretary.

The following were elected to membership on the Council of the Institute: Charles H. Colvin, member A.S.M.E., Ralph S. Damon, Albert I. Lodwick, Earl D. Osborn, Elmer A. Sperry, Jr., member A.S.M.E., and Philip B. Taylor.

The Institute presented honors and awards at its honors night and annual dinner held at the Biltmore in New York City on Jan. 26, as follows:

The Daniel Guggenheim Medal was awarded to Donald W. Douglas, president of the Douglas Aircraft Co., Santa Monica, Calif., "for outstanding contributions to the design and construction of transport airplanes."

The Sylvanus Albert Reed Award was presented to George J. Mead, member A.S.M.E. and vice-chairman of the National Advisory Committee for Aeronautics, "for the design and development of high-output aircraft engines for military and commercial services."

The Octave Chanute Award was presented to Edmund T. Allen, director of flight and research, Boeing Aircraft Co., Seattle, Wash., "for his outstanding contributions to methods and procedure in flight research in connection with airplane design and operation."

The Lawrence Sperry Award was presented to Charles M. Kearns, Jr., Junior A.S.M.E., and project engineer, Hamilton Standard Propellers Division, United Aircraft Corp., East Hartford, Conn., "for the successful application of methods of measuring propeller vibration stresses in flight."

Postgraduate Education Encouraged by Industry

LIKE many of the larger companies, Westinghouse cooperates with neighboring educational institutions to provide its young engineers with postgraduate training in engineering and allied fields. In some cases, arrangements are made whereby credit is granted toward the master's or doctor's degree if the student so desires. In the Westinghouse Company, young engineers in the Pittsburgh, Lima, and Sharon areas are enrolled in the University of Pittsburgh; and in the New York metropolitan area, in New York University, Polytechnic Institute of Brooklyn, or Stevens Institute of Technology. The fees for the courses are $5 per semester for one or more company courses and the regular fee per credit for courses which are taken at the school. In Pittsburgh, the University fee is $10 per credit.

Societies' Library Supplies Engineering Hero for the Movies

MANY engineering facts and figures are buried in the thousands of books and periodicals contained in the collection of the greatest technical library in the world, the Engineering Societies Library, New York, N. Y. Because of this, several requests, made in person or by telephone or mail, come in every day from A.S.M.E. members, engineers, schools, manufacturers, and governmental agencies for lists of books and articles on a particular subject, for photostats of diagrams, or for pertinent information about some engineering detail. Infrequently, the staff in the Search Department gets a request which is more humorous than technical. Such a request was received recently over the telephone from a young lady who was creating an engineering hero for a movie scenario.

The librarian answering her request was told that she could take care of the love interest, the boy-and-girl angle, and the Hays office, but she needed advice about the training and experience of her young engineering hero. From a list of the best engineering schools in the country read to her, she selected one of them to train the young man. The young lady insisted that since he had such a exceptional mind, the young engineer should receive not only an aeronautical-engineering degree but also a doctor's degree. She then brought him to New York where he received a job with an outstanding airplane manufacturer. Not very long after he started in his new job, the young engineer invented a revolutionary something. After much discussion with the librarian about the parts of an airplane, the scenarist chose a carburetor as the necessary something.

Of course, everyone was ready to steal this wonderful invention, but after much fighting our engineering hero finally won fame, money, and, of course, the girl as his wife.

Iowa State College Issues Booklet on Iowa Coals

BULLETIN 144 on "Use of Iowa Coals in Domestic Stokers" has just been issued by the Engineering Experiment Station of Iowa State College, Ames, Iowa, and may be obtained without charge by A.S.M.E. members. The research investigation reported in this bulletin not only included Iowa coals but also Illinois, Indiana, Kentucky, and West Virginia coals commercially available in Iowa. An unusual feature of the investigation was the testing of various coal mixtures. Actual combustion tests were carried out in a typical stoker-fired domestic plant.

Local Sections

Coming Meetings

Anthracite-Lehigh Valley. March 22. Auditorium of the Reading Railroad Co., Y.M.C.A., at 8:00 p.m. Subject: "Steam Locomotive Slipping Tests," by T. V. Buckwalter, vice-president, The Timken Roller Bearing Co., assisted by Walter C. Sanders, general manager, railway division, and O. J. Horger in charge of railway engineering and research.

Baltimore. March 12. Engineers Club of Baltimore at 8:15 p.m. Subject: "Various Types of Bearings," by Gustave Fast, president of the Fast Bearing Company, Annapolis, Md.

Buffalo. March 19. University Club, Buffalo, N. Y. Subject: "Diesel-Engine Development and Research," by Harte Cooke, consulting engineer, American Locomotive Co., Auburn, N. Y.

Central Indiana: March 15. Rose Polytechnic Institute, Terre Haute, Ind., at 6:30 p.m. Subject: "Municipal Control of Atmospheric Pollution," Robert H. Kuss, technical adviser of the Smoke Abatement League of Terre Haute.

Florida. April 11. Hollywood Beach Hotel, Hollywood, Fla., at 9:00 a.m. This will be an all-day meeting, and the program is now under way.

New Orleans. March (date and time to be announced later). Joint Meeting of Section and Louisiana State University Student Branch. Meeting to be held at Baton Rouge or at L.S.U. if tentative plans develop as proposed. Inspection trip of large industrial plant followed by paper presented by Baton Rouge speaker.

Philadelphia. March 26. Philadelphia Engineers Club at 8:00 p.m. Between the dinner at 6:00 p.m. and the meeting proper at 8:00 p.m. there will be shown a film on "Mechanical Drives and Movements in the Manufacture of Centrifugal Cast Iron Pipe," by courtesy of the Florence Pipe and Foundry and Machine Company. Subject: "Mechanical Movements, Speed Reducers, and Power Transmissions," by engineers of the Link Belt Company, Philadelphia, Pa. Discussers: Messrs. William Staniar, mechanical engineer of the du Pont Company, and Joseph Bennett of the American Engineering Company.

Providence. March 5. Engineering Societies Building at 8:00 p.m., Providence, R. I. Subject: "Machine Tools," by Erik Oberg, editor of *Machinery*, New York, N. Y.

San Francisco. March 28. Engineers Club, 206 Sansome St., San Francisco, Calif. This will be a National Defense Meeting.

Schenectady. March 21. Meeting at 8:00 p.m.; probably will be held at Edison Club Hall, State and Washington Sts., Schenectady, N. Y. Subject: "Waves, Words, and Wires," by J. O. Perrine, assistant vice-president, American Telephone & Telegraph Co., New York, N. Y.

Susquehanna. March 4. Rooms of the York Engineering Society. This will be a special-event meeting with York Engineering Society. Subject to be announced later.

CAN WE AFFORD TO MAKE
THESE EASIER-READING

American Engineering Council

Presents

The News From Washington and Elsewhere

A.E.C. Changes Quarters

EFFECTIVE February 15, American Engineering Council shifted its offices in Washington, D. C., from the old quarters which it had occupied since 1922 to a new location at 919 Seventeenth Street, N. W., where it will occupy a building jointly with the American Forestry Association and immediately adjoining the Army and Navy Club.

The new offices are conveniently located only a block distant from the old, and will provide facilities better adapted to the needs of Council, which requires much storage space for the valuable records accumulated during the last twenty years. These are now more readily accessible. In addition, there will be a distinct saving in rental charges, making it possible to devote a larger proportion of the annual budget to productive activities. Engineers and others interested in Council's activities are cordially invited to visit the new offices whenever they are in Washington.

T.N.E.C. States Plans

Having given recent consideration to the characteristics of cartels and completed hearings on steel and life insurance, the Temporary National Economic Committee through its chairman, Senator Joseph C. O'Mahoney, of Wyoming, has announced its plans for winding up the inquiry, which began late in 1938.

Additional hearings will be held on at least three subjects: Interstate trade barriers; the impact of technological development upon employment; and, finally, an economic free-for-all at which the Committee will listen to witnesses desiring to present ideas for the solution of economic problems. In its investigation of technical change the Committee is expected to examine a number of fields of business, and particularly the machine-tool industry. Much basic material is available as the result of a comprehensive study of this question that has been under way for several years under the sponsorship of the research division of the Works Projects Administration.

California Urged to Form Public Power Agencies

In answer to requests by California officials for information on how to cooperate in the future operation of the Central Valley power and irrigation project, now under construction, Secretary of the Interior Harold L. Ickes has written a letter to Governor Olson pointing out that the law requires the Bureau of Reclamation, in marketing power from its projects, to give preference to public agencies. It is also usual policy to turn over to responsible local organizations the operation and maintenance of those portions of projects which serve them with water.

Industrial Facts and Figures Forms Part of 1940 Census

AS A PART of the sixteenth decennial census of the United States, which is in progress now, the enumerators are also collecting facts and figures on activities during 1939 in the machinery and metal-working industries, the iron and steel industry, mining, power generation, and other manufacturing fields. In other words, the 1940 census is attempting to get an over-all picture of all industrial and trade activities, including production, costs, and sales of every product made in 1939, from pins and needles to streamlined locomotives.

The data now being collected will be more complete than for any previous year. The figures will be made public, Bureau of Census officials estimate, long before the end of this year. Thousands of census takers have been in the field since the first part of January calling on representatives of the various industries. The field work will be completed, it is anticipated, before the end of April and the great bulk of the information will be published by late summer or early fall.

Prime Movers Included

Figures on production and the value added by manufacture, which are collected every two years, will be supplemented in the current Census of Manufactures with information on the expenditures during the year for new machinery, plant expansion, and alterations. And, for the first time in ten years, complete data will be recorded on power and fuel. There will be statistics on the number and capacity of prime movers, generators, and motors, as well as the amount and cost of fuel used last year—coal, coke, fuel oil, and gas—and the number of kilowatthours of electric energy generated in the plant, purchased, and sold.

The total costs of materials used in the manufacture of machinery, tools, machine-shop products and accessories, and figures on specific materials used will be recorded—the tons and cost of pig iron, iron and steel scrap, rods, bars, and wire. Similar figures will be recorded on iron and steel plates, strips, and sheets used by the makers of hardware, screw-machine products, nuts, bolts, rivets, as well as on the materials consumed by the manufacturers of nearly all metal products—plumbers supplies, cutlery, sheet-metal products, pumps, heating and cooking equipment, transportation equipment, agricultural implements—the steel works and rolling mills, the makers of blast-furnace and foundry products.

Man-Hours

Supplementing the information on manufacturing operations will be detailed figures on man-hours—production per man per hour—up-to-date data which will throw new light on the relationship between production and man power. The total number of man-hours worked by all wage earners in the machinery and metal-working industries is being collected, the number of workers employed each month, reflecting the trend of employment during the year, the salaries and wages classified by occupations—manufacturing, selling, technical, and clerical work.

Plan Pan American Scientific Meeting

Preliminary plans for the eighth American Scientific Congress, to be held in Washington May 10 to 14, 1940, have been announced by the Department of State following the dispatch of invitations to participate to the governments of all American republics affiliated with the Pan American Union. An organizing committee has already been named, headed by Under Secretary of State Sumner Welles and composed of a number of distinguished heads of scientific and governmental bodies, including Dr. C. G. Abbot and Dr. Alexander Wetmore of the Smithsonian Institution, Dr. Isaiah Bowman of Johns Hopkins University, Dr. Vannevar Bush of the Carnegie Institution, Dr. Ross G. Harrison of the National Research Council, Dr. James Brown Scott of the Carnegie Endowment for International Peace, and Dr. Leo S. Rowe of the Pan American Union.

At a recent meeting of this organizing committee it was decided to divide the Congress into eleven sections, each to be in charge of a chairman to be assisted by a vice-chairman and a section committee, which will soon be selected. The sections will cover, respectively, the anthropological sciences; the biological sciences; the geological sciences; agriculture and conservation; public health and medicine; physical and chemical sciences; statistics, history, and geography; international law, public law, and jurisprudence; economics and sociology; and education.

Oil-Burner Standard

Copies of a printed pamphlet entitled "Automatic Mechanical Draft Oil Burners Designed for Domestic Installations, Commercial Standard CS75-39," which has been accepted by the industry as its standard of practice for new production, may be obtained from the Division of Trade Standards, National Bureau of Standards, Washington, D. C.

New York Efficiency Bill

A model "Public Projects Efficiency Bill" that will authorize the state and local units of government to hire independent engineers to check in advance public-works-project plans for economy, safety, practicability, and other technical features was introduced in the New York State legislature on Jan. 12, by State Senator Thomas C. Desmond, of Newburgh, N. Y. The bill would permit the employment of independent engineers before construction is begun on a public-works project and their recommendations would be made public.

(*A.S.M.E. News continued on p. 268*)

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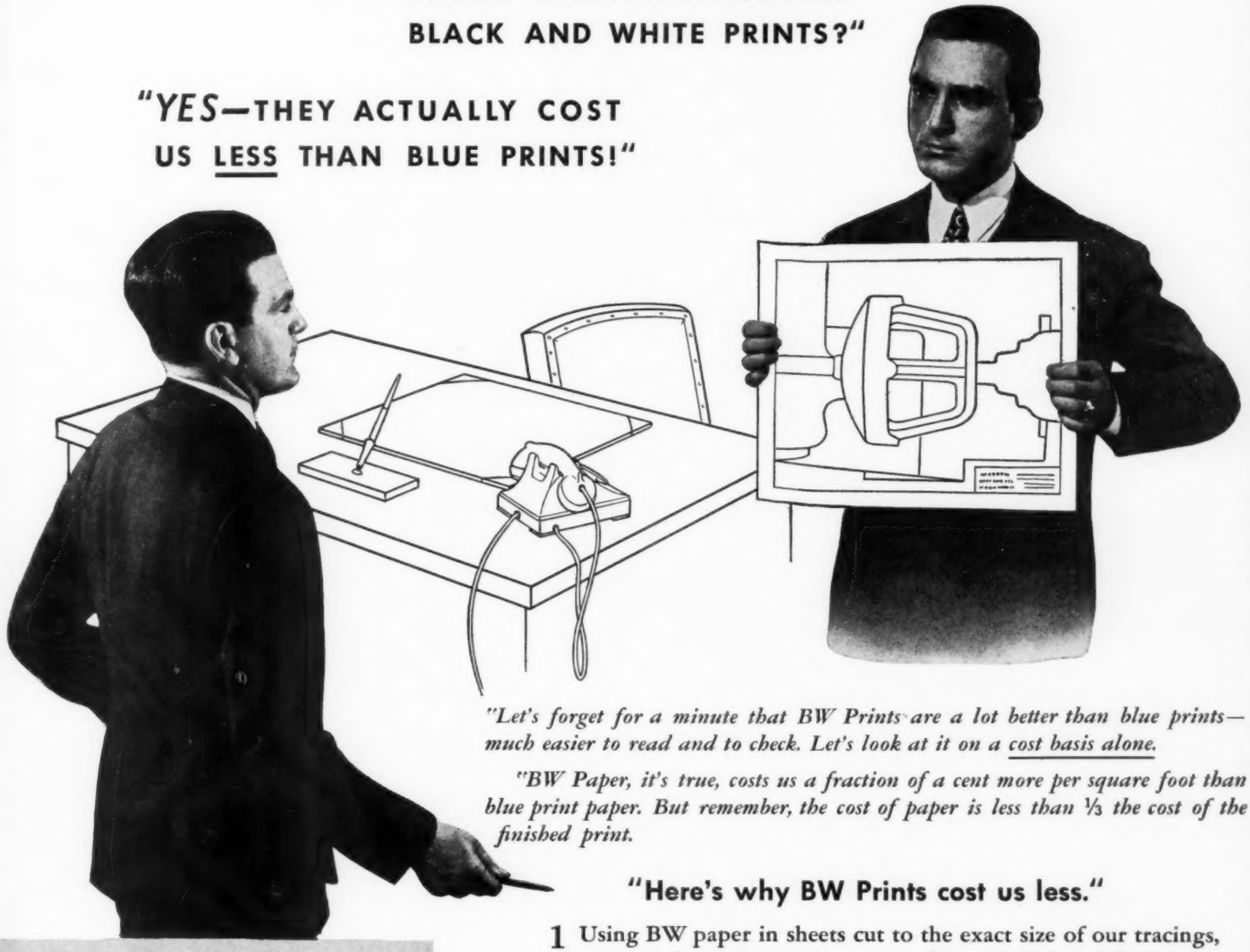
THESE EASIER-READING
BLACK AND WHITE PRINTS?"

"*YES*—THEY ACTUALLY COST
US LESS THAN BLUE PRINTS!"



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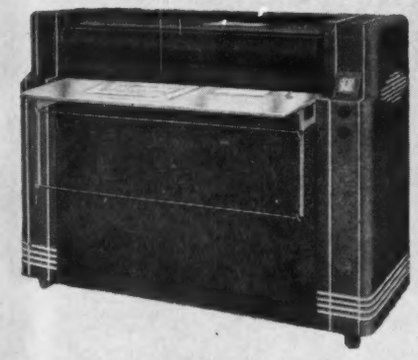

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Men and Positions Available

Send inquiries directly to
Engineering Societies Employment Service
29 West 39th St. New York, N. Y.

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 29. Five years' experience supervising mechanical equipment and production in wire, rod, and seamless-tube mill. Operations include grinding, annealing, pickling, heat-treating, design, and making of dies. Now employed. Me-429.

MECHANICAL-ELECTRICAL ENGINEER, 32, married, master's degree. Ten years' experience developing, designing, manufacturing various mechanical, electrical, and hydraulic equipment. Inventive ability. Metallurgical and sales experience. Made management studies. Now employed. Me-430-3911-D-3-San Francisco.

PRODUCTION AND DEVELOPMENT ENGINEER, M.E., 32. Ten years tool, gage, design; manufacturing methods, equipment, development; electrical apparatus; three years supervisor production planning, inventory control; 9 years evening-technical-school instructor. Me-431.

ENGINEERING EXECUTIVE, age 35, graduate M.E., now employed. Available for position requiring experience in business administration, contract writing and negotiation, work scheduling, sales, advertising. Oil or process industries preferred. Me-432.

CHIEF ENGINEER, M.I.T. graduate, 37, married. Experience directing commercial refrigeration, household refrigeration, air-conditioning research, design, production engineering, and sales application; 6 years' European experience; interested in engineering commercial administration. Me-433.

MECHANICAL ENGINEER, 28, married, graduate Purdue University, B.S.M.E., also graduate work; 5 years' experience including machine shop, machine and tool design, plant engineering, and production. Desires responsible position. Now employed. Me-434.

MANUFACTURING PLANT MANAGER OR SUPERINTENDENT, organizer, coordinator, thoroughly conversant all plant activities, controls for materials, production, costs. Background of industrial engineering experiences in mechanical- and electrical-products plants and in process industries. Me-435.

EXECUTIVE, 25 years' experience as industrial engineer, factory superintendent, and general manager installing modern methods and equipment in machinery and metal-trades manufacturing plants and operating same with full responsibility. Me-436.

MECHANICAL ENGINEER, 37, single, M.E. Stevens, 1924; M.S., M.I.T., 1934. Eight years power-plant testing; 4 years inspection with Navy; good theoretical background. Desires engineering opportunity preferably in East. Me-437.

DESIGNER AND DRAFTSMAN, graduate civil engineer, 30. Experience in refrigeration, machine design, structural steel, and concrete design and detail. Handled labor and supervised construction. Registered surveyor. Me-438.

CENTRIFUGAL PUMP DESIGNER, graduate mechanical engineer; 9 years with leading pump-manufacturing concern; experienced in all types of pumps with exceptional performances; can take charge of engineering. Me-439.

ENGINEER, B.S.M.E., 29, single. Seven years project engineer with one company. Wide experience on spot-welded and arc-welded stainless and carbon sheet-steel structures. Location unimportant. Desires position with future. Me-440.

Employment Service Can Place More Mechanical Engineers

AN INCREASE of 10.6 per cent in the number of jobs received by the New York office of the Engineering Societies Employment Service for January, 1940, as compared to the same month in 1939, is reported by A. H. Meyer, secretary of the Service. For the Chicago office the increase is 29.2 per cent, which indicates great activity on the part of industries in the Middle West. It is particularly interesting to note that the majority of the positions available are in the field of mechanical engineering.

In checking over the positions available and men available at this period, Mr. Meyer notes a scarcity of properly qualified and experienced men for the following positions: Executives and administrators for positions paying $5000 a year or more, designers for the aviation, ordnance, machine-tool, and machinery industries, and time-study and production engineers. The lack of applicants for the last position mentioned is so great that a young engineer with suitable training is assured of immediate placement upon registration with the Service. However, despite the difficulties of getting the right men for the various jobs, the Service, which is maintained by the A.S.M.E. and the other Founder Societies, is still keeping up its high ratio of jobs received and jobs filled. Where a job cannot be filled by a member of one of the Founder Societies, the Service may fill it with a nonmember.

All communications received at the Engineering Societies Employment Service are treated in a confidential manner which may be one of the reasons why it is so successful in its particular field. If any member of the A.S.M.E. is interested in obtaining engineers for positions in his plant, a letter to the Service will get the results. Unemployed men and engineers desiring to change their positions are directed to the list of positions available on pages 268–269 of this issue.

[1] All men listed hold some form of A.S.M.E. membership.

POSITIONS AVAILABLE

SALESMAN, graduate mechanical engineer, 25–30. Should have metallurgical background, and knowledge of high-temperature and high-pressure alloys. Company manufactures tubing for oil refineries. Location, New York, N. Y. Y-5208.

SALES ENGINEER, 30–40, graduate mechanical engineer for company manufacturing vibration absorbers. Salary, $200 month. Location, Ohio. Y-5224.

DESIGNER, young, with 4 or 5 years' experience in modern gear design and related work. Location, Pennsylvania. Y-5231.

SUPERVISOR OF TRAINING, graduate engineer, 30–35, who has had practical experience in training activities. Will be responsible for development of training program covering operating, administrative, and office personnel, involving about eight thousand employees in nine plants and 25 branch offices. Functions of this department will constitute mainly training on the job, development of company courses, employee manual, training schedules, organization progression charts, and other duties incidental in creating and administering program of this type. Location, Middle West. Y-5265C.

DESIGNER, graduate mechanical engineer, not over 35, for compressor and steam-engine work. Should have at least two years' experience in reciprocating machinery of similar nature, and should have been graduated from recognized engineering school. Location, Pennsylvania. Y-5295.

TIME-STUDY ENGINEER, 27–40, graduate mechanical or industrial engineer with at least three years' time-study experience in industries of short-cycle operations. Duties will be to make time and motion analyses by use of watch or film, compile standard data, establish base rates, piece rates, and fatigue factors, and aid in installation of incentive systems. Apply by letter enclosing small recent photograph. Salary, $200 month. Location, Pennsylvania. Y-5296.

DESIGNER, 30–40, who can handle plastic as well as metal-stamping molds and dies. Work will be chiefly on board designing plastic molds, and applicant should be well informed in both injection and compression work. Should also have knowledge of shop practice, as he will be required to follow the work through shop. Salary, $200–$275 month. Location, Middle West. Y-5297C.

MECHANICAL DRAFTSMAN with experience in compressor design and manufacture. Company requires man with good practical compressor experience in drafting room and also adequate shop experience or familiarity with shop practice, and who is willing to work on the board. Location, New Jersey. Y-5314.

SENIOR PROJECT ENGINEER, graduate mechanical or chemical engineer, 35–45, who has held similar position in chemical-process manufacturing plant. Salary, $4000 year. Location, New York metropolitan area. Y-5324.

MECHANICAL ENGINEER for design of X-ray electrosurgical and allied apparatus. Must have practical experience and enough acquaintance with electrical principles to work intelligently with electromedical equipment. Sal-

(A.S.M.E. News continued on p. 270)

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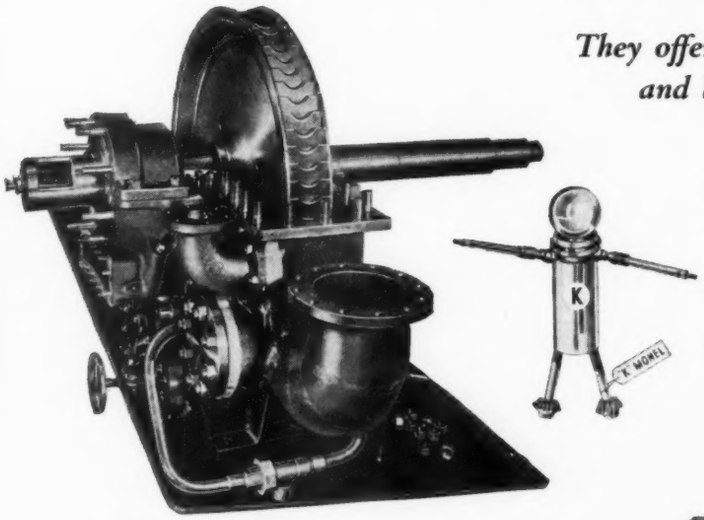
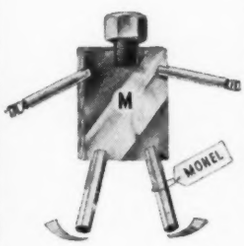
LICKING TOUGH JOBS WITH FOUR HUSKY METALS

They offer unusual properties that improve performance and lengthen life of many kinds of equipment



"K" MONEL *for High-Strength and Hardness:* Because of its combination of strength plus corrosion resistance, Monel has long been a popular metal. A newer alloy, "K" Monel* now offers even greater strength and can be hardened by heat treatment to 265-315 Brinell—tensile strength 140-170,000. A typical application for "K" Monel is the shaft in the direct drive turbo-propeller type pump at left. Only 6'3" in length, this pump has a capacity of 19,500 g.p.m.

"S" MONEL *for Hardness and Non-galling:* Cast "S" Monel* possesses hardness up to 325 Brinell (which is retained at high temperatures) and valuable non-galling characteristics. Utilizing a steam pressure of 410 pounds, temperature 700° F., the installation shown at the right employs "S" Monel for valve trim.

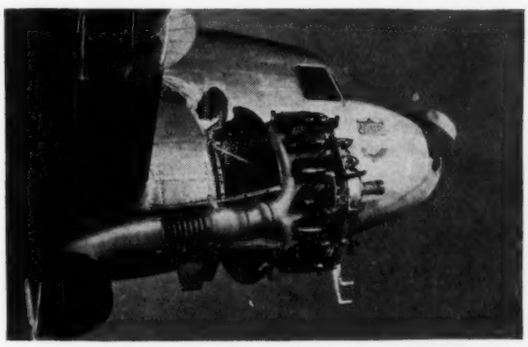


MONEL *for Strength and Toughness:* In addition to having the strength and toughness of steel, Monel* is rust proof and resistant to a long list of corrosives including salt. So Monel shafts in boats, pumps and valves in salt water service *retain* their strength and afford years of dependable service. Many new fishing boats, and old ones too, are accordingly putting in Monel shafts, as shown at left. Losses caused by failure of propeller shafts, in one case including a $30,000 cargo, no longer will plague commercial fishermen.

INCONEL *for High Temperature Service:* Excellent forming qualities, resistance to corrosion and exceptional strength at high temperatures, have made Inconel* the preferred metal for many high temperature applications. Used by leading airlines for exhaust manifolds as shown at right, it is also employed for shrouding, fire-walls and cabin heaters . . . all of which must resist severe corrosion and heat.

• • •

Wherever you need a strong, rust proof metal, use Monel or one of the other Nickel-base alloys. Which one *to use depends on the* additional *properties you need . . . heat treatability . . . exceptional hardness . . . resistance to heat . . . good spring properties, etc. Write for basic information sheets about each.*



THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street **New York, N.Y.**

MONEL AND OTHER HIGH NICKEL-COPPER ALLOYS

"Monel" and other trade-marks which have an asterisk associated with them are trade-marks of The International Nickel Company, Inc.

ary, about $50 week. Location, Ohio. Y-5330-R-755C.

YOUNG ENGINEER, about 30, preferably graduate with business-administration degree, for newspaper publisher. Work will be to investigate, first, circulation and later to check various departments in newspaper business. Salary, up to $50 a week. Location, New England. Y-5332.

DISTRICT SALES MANAGER, not over 40, with thorough background in burning of fuel and steam generation. Must be good engineer, and have had considerable sales experience. Salary, $5000–$6000 year. Location, East. Y-5336.

DEVELOPMENT ENGINEER, graduate mechanical engineer, about five or ten years out, who has experience in sheet-metal design work and who is resourceful, imaginative, and cost-conscious. Work will be to assist in development of new product for company engaged in production of refrigerator cabinets. Location, Middle West. Y-5337C.

EXECUTIVE ENGINEER, 35–50, for vice-presidency of large manufacturing company. Must have been trained in engineering, i.e., machine construction, design, and development. Must be alert-minded and understand marketing of product to keep ahead of competitors. Salary, $10,000–$12,000 a year. Location, New York metropolitan area. Y-5355.

ASSISTANT TO GENERAL SUPERINTENDENT, graduate mechanical engineer; experienced in boiler work, power, heating, and ventilating. Must be thoroughly capable of estimating and laying out work and be familiar with the A.S.M.E. code on unfired pressure vessels. Should be able to go out and solicit business. Middle-aged man preferred. Salary open. Location, Connecticut. Y-5357.

Coming Civil Service Tests

U. S. CIVIL SERVICE COMMISSION:

Senior inspector, ordnance material, $2600 a year; inspector, ordnance material, $2300 a year; associate inspector, ordnance material $2000 a year; assistant inspector, ordnance material, $1800 a year; junior inspector, ordnance material, $1620 a year. Applications will be considered and rated approximately as received until May 22, 1940, unless an eligible register sufficient to meet the needs of the Ordnance Department, U. S. Army, is obtained sooner, in which event due notice will be given.

Chief engineering draftsman, $2600 a year; principal engineering draftsman, $2300 a year; senior engineering draftsman, $2000 a year; engineering draftsman, $1800 a year; assistant engineering draftsman, $1620 a year—for work on ships. Optional branches: (1) Electrical, ship, (2) hull structures, arrangements, and fittings, (3) marine engines and boilers, (4) piping, ship, and (5) ventilation, ship. Applications may be filed with the Commission until further notice. Applications will be rated as received.

Further information and application forms may be obtained from the U. S. Civil Service Commission, Washington, D. C., or from one of its local offices in first-class post offices.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after March 25, 1940, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Reelection; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

AVERILL, EARL A., Adams, N. Y. (Rt & T)
BALKA, WM. H., Dallas, Tex.
BATES, RALPH E., Chicago, Ill.
BIEVER, EDMUND J., Kohler, Wis. (Rt)
BOWERS, ROBT. D., Columbus, Ind.
BUCKHOLTZ, IRA E., Palo Alto, Calif.
DI CESARE, FRED PANFILO, New York, N. Y.
DRAKE, F. B., San Francisco, Calif. (Rt)
DRAKE, THOS. S., Welland, Ont., Can.
ENNIS, J. E., New York, N. Y.
FILLMAN, CHAS. W., Cleveland, Ohio
GUNG, GEO., Toronto, Ont., Can.
HOWARD, ALAN, Schenectady, N. Y.
LADD, RALPH H., Philadelphia, Pa.
LARSON, BERT E., Chicago, Ill.
LAUGHNAN, T. GERALD, Chicago, Ill.
LAYTON, J. WM., Osborne, Ohio
LE BAILLY, ANDREW R., Chicago, Ill.
MACDONALD, G. A., River Edge, N. J.
MALONE, T. H., JR., El Paso, Tex.
MASON, R. A., Philadelphia, Pa. (Rt)
MCCLEARY, ROYAL E., Angola, Ind. (Re)
MIDDLESWORTH, G. M., Chicago, Ill.
MINARIK, R. F., Chicago, Ill. (Rt & T)
MORTON, HARRY E., Chicago, Ill.
PLUMLEY, R. G., Stamford, Conn.
POTTER, JAS. T., Birmingham, Ala.
REESE, JOHN S., San Francisco, Calif.
REICHERT, GEO. L., JR., Chicago, Ill. (Re)
REYNOLDS, SAML. D., Rutledge, Pa. (Rt & T)
ROBERTS, W. STEWART, Swampscott, Mass.
ROBINSON, J. W., San Mateo, Calif.
ROOT, MARSHALL J., Woonsocket, R. I.
RUSH, RALPH M., Pittsburgh, Pa. (Rt)
SANDERSON, WM. H., JR., Phillipsburg, N. J.
SAUNDERS, FRED Q., Richmond, Va. (Re)
SCARLETT, ARTHUR C., Medina, N. Y.
SHAW, EARL W., JR., Worcester, Mass.
SHULTERS, E. S., Wash., D. C.
SMITH, ELLIOTT DUNLAP, New Haven, Conn.
SMITH, LESTER C., Hartford, Conn.
TAYLOR, IRVING, Hoboken, N. J. (Re)
TAYLOR, JESSE, JR., North Hills, Pa. (Rt)
TOBIN, ARTHUR R., Chicago, Ill.
TRUMPLER, WM. E., Easton, Pa.
VOSTI, ALBERT P., Gonzales, Calif.
WEIGEL, ELMER H., Kenmore, N. Y.
WELLS, ROBT. L., Pasadena, Calif.
WOCKENFUSS, WM., Vestal, N. Y.
WOODROW, HARRY R., New York, N. Y.
YEAGER, B. J., Cincinnati, Ohio

CHANGE OF GRADING

Transfers to Member

BLACK, HENRY M., Chicago, Ill.
CAPP, WM. C., Columbia, S. C.
LINDAHL, E. J., Columbus, Ohio
VARGA, GIDEON M., Bronx, N. Y.

Transfers from Student-member to Junior 4

A.S.M.E. Transactions for February, 1940

THE February, 1940, issue of the Transactions of the A.S.M.E. contains the following papers:

TECHNICAL PAPERS

Some Problems in the Design and Operation of Merchant Vessels, by R. C. Lee
Problems of the Highway User in the United States, by F. C. Horner
Wear of Diesel-Engine Cylinders and Rings, by P. S. Lane
Where Does Interpretation Begin?—Analysis of the Oil-Engine Power Cost Report, by P. H. Schweitzer
Stability of Crankcase Oils, by W. F. Weiland
Whip Stress in a Locomotive Main Rod at 100 Miles per Hour, by M. W. Davidson
Viscosity of Coal-Ash Slags, by P. Nicholls and W. T. Reid

DISCUSSION

On previously published paper by Messrs. G. F. Wislicenus, R. M. Watson, and I. J. Karassik.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

BURKE, JAMES, January 21, 1940
CHATEL, FRED J., April 24, 1939
CONRAD, W. L., November 29, 1939
DIEHL, A. N., January 3, 1940
HAWLEY, THOMAS, January 20, 1940
HULSMAN, HERBERT W., October, 1939
MCLEAN, JAMES S., January 1, 1940
POPKIN, MARTIN E., January 28, 1940
PYZEL, EWALD, October 12, 1939
RANDALL, NORMAN, December 18, 1939
SIMMERING, S. L., January 28, 1940
VAUCLAIN, SAMUEL M., February 4, 1940
ZOWSKI, S. J., January 11, 1940